PROCEEDINGS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY

HELD AT PHILADELPHIA

FOR

PROMOTING USEFUL KNOWLEDGE.

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DETROIT, MICH.

Vol. XXII.

JANUARY TO OCTOBER, 1885.

PHILADELPHIA:
PRINTED FOR THE SOCIETY
BY M'CALLA & STAVELY.
1885.

R506A6
v.22 pt.1-2,4 [1885]

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A6
V.22 pts 1-2, 4
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Subscription Price, $4.00 per Annum; to Members $1.00.

Entered at the Philadelphia Post-Office as second-class matter.

PUBLISHED QUARTERLY.

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VOL. XXII. JANUARY, 1885. PART I. No. 117.

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PUBLISHED FOR THE AMERICAN PHILOSOPHICAL SOCIETY,

BY

McCALLA & STAVELY,

NOS. 237-9 DOCK STREET, PHILADELPHIA.

EXTRACT FROM THE BY-LAWS.

CHAPTER XII.

OF THE MAGELLANIC FUND.

SECTION 1. John Hyacinth de Magellan, in London, having in the year 1786 offered to the Society, as a donation, the sum of two hundred guineas, to be by them vested in a secure and permanent fund, to the end that the interest arising therefrom should be annually disposed of in premiums, to be adjudged by them to the author of the best discovery, or most useful invention, relating to Navigation, Astronomy, or Natural Philosophy (mere natural history only excepted); and the Society having accepted of the above donation, they hereby publish the conditions, prescribed by the donor and agreed to by the Society, upon which the said annual premiums will be awarded.

CONDITIONS OF THE MAGELLANIC PREMIUM.

1. The candidate shall send his discovery, invention or improvement, addressed to the President, or one of the Vice-Presidents of the Society, free of postage or other charges; and shall distinguish his performance by some motto, device, or other signature, at his pleasure. Together with his discovery, invention, or improvement, he shall also send a sealed letter containing the same motto, device, or signature, and subscribed with the real name and place of residence of the author.

2. Persons of any nation, sect or denomination whatever, shall be admitted as candidates for this premium.

3. No discovery, invention or improvement shall be entitled to this premium, which hath been already published, or for which the author hath been publicly rewarded elsewhere.

4. The candidate shall communicate his discovery, invention or improvement, either in the English, French, German, or Latin language.

5. All such communications shall be publicly read or exhibited to the Society at some stated meeting, not less than one month previous to the day of adjudication, and shall at all times be open to the inspection of such members as shall desire it. But no member shall carry home with

PROCEEDINGS

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AMERICAN PHILOSOPHICAL SOCIETY,

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VOL. XXII. 1884. No. 117.

The Extinct Mammalia of the Valley of Mexico. By E. D. Cope.

(Read before the American Philosophical Society, May 16, 1884.)

The following study is based primarily on an examination of the specimens contained in the Museum Nacional of Mexico, which I was permitted to make through the kindness of the Director of the Departments of Geology and Mineralogy, Professor Mariano Barcena. Through the mediation of the same gentleman, I obtained permission from Professor Antonio Castillo, Director of the School of Mines, to examine the corresponding material preserved in the fine museum of that institution. The knowledge derived from the study of the latter, reinforced the results I obtained from the study of the specimens of the Museum Nacional, so as to enable me to reach definite conclusions as to the definitions of various species which are represented in both collections. I wish to record the obligations under which I have been laid by both of these distinguished gentlemen. I have, through their aid, been enabled to make a comparison between the pliocene fauna of Mexico, and that of Buenos Ayres, and that of Oregon. The species of the Pampean fauna contained in my private collection, are those exhibited by Messrs. Ameghino, Larroque and Brachet, at the Exposition of Paris of 1878. My Oregon material is derived from the explorations of my parties under Messrs. Sternberg and Duncan, and those of Professor Thomas Condon of the University of Oregon, who kindly lent me his collection.

The collections of the museums of the City of Mexico, above mentioned, are derived from the locality Tequixquiac, and the specimens referred to in the following pages are to be understood as having been derived from that locality unless otherwise stated. Tequixquiac is situated on the northern edge of the valley of Mexico, north of the City of Mexico and the town of Zimpango, and east of the gorge of Nochistongo.

PROC. AMER. PHILOS. SOC. XXII. 117. A. PRINTED OCTOBER 21, 1884.

GLYPTODON Owen.

GLYPTODON, sp. indet.

A nearly complete carapace of this remarkable animal is mounted in the Museum Nacional, and a second, nearly as well preserved, is in the Museum of the School of Mines. Jaws and teeth occur in the latter museum. The discovery of this genus at this extreme northern locality is due to Dr. Antonio Castillo. It was first announced by Dr. Mariano Barcena in the Revista Cientifica of Mexico, 1882, I, p. 3. The extension of this far southern genus to the latitude of Mexico during the Pliocene (Pampean) epoch, is entirely consistent with the further distribution of the great sloths and llamas to the United States at the same time.

DIBELODON Cope.

Mastodon pars, auctorum.

Various attempts have been made to define as genera groups of species which are included within the limits of the genus Mastodon of authors. The first new name, Tetracaulodon, was introduced by Dr. Godman, who saw in the mandibular tusks of some individuals of the *Mastodon americanus* Cuv., ground of its separation from the genus Mastodon, in which he believed those teeth to be wanting. This division was adopted by Dr. Grant and others, but has not been generally allowed. The next division was that proposed by Dr. Falconer, who, however, did not employ the names proposed by him in more than a subgeneric sense. He distinguished two series in the genus Mastodon. In one of these, the P-m. 3, and the Ms. 1 and 2 present three transverse crests, while in the other division these teeth present four such crests. To these divisions he gave the names of Trilophodon and Tetralophodon respectively. The third attempt at division is that of Herr Vacek, who gives names to the two divisions of the genus in which the cross-crests are composed of tubercles or continuous ridges. These divisions he calls Bunolophodon and Zygolophodon respectively.*

I will refer to these divisions in reversed order. Those proposed by Vacek cannot be regarded as genera, and their author did not use them as such. The tubercular crest passes into the straight crest by insensible stages. The divisions proposed by Falconer are more distinct, but not sufficiently so to represent genera. This may be understood by reference to the second lower molar of the *Mastodon augustidens*, which is, in some individuals, three crested, and in others four crested. Some other species present the same difficulty. On this point I quote the remarks of Dr. Lydekker:† "The foregoing survey of such a large series of Mastodon molars has led to the conclusion that the very regular ridge formula given by Falconer will not always hold good in regard to the true molars,

* Vacek, Ueber Oesterreichische Mastodonten. Abh. der K. K. Geolog. Reichanstalt, vii, Heft iv, Wien, 1877. p. 45.

† Geological Survey of India, Series x, Vol. i, pt. v, 1880, p. 256.

though in the Indian species, at all events, it appears to be always constant in the milk-molars. We have seen that there is a tendency in the true molars of some of the Trilophodons (*M. falconeri*) to develop the talon into a fourth ridge, and in the Tetralophodons (*M. latidens* and *M. sivalensis*), a similar talon is developed into a fifth ridge, in the intermediate true molars." *M. humboldtii* Cuv. (*M. andium* Falc.*) shows a small fourth crest on the second true molar, according to Falconer.†

The lower incisor teeth, on which Godman relied for the definition of his genus Tetracaulodon, were shown by Harlan, not to be constantly present in the *Mastodon americanus*. In fact, no adult specimen has been described in which two inferior incisors are present. The single one observed is very rarely found in adults, being a character more frequently found in the young. It is in this species a remnant of a character elsewhere constant, which does not disappear quite so soon as the teeth of the whalebone whale, and superior incisors of the ruminant. But it is otherwise with other species referred to Mastodon. No specimens of the *Mastodontes angustidens, productus* and *longirostris*, are recorded, in which two inferior incisors are not present. For this reason the first and last-named were placed by Grant and others in the genus Tetracaulodon. Unfortunately this name was applied by its author to the *M. americanus* only, a species which cannot enter the genus furnished with a pair of persistent inferior incisors. It is also the type of Cuvier's Mastodon.‡ It thus unavoidably becomes a synonym of the latter.

There is no doubt that the presence of a pair of persistent inferior incisors defines a genus as distinct from one in which there is not a pair of permanent inferior incisors. I agree, therefore, with Grant and others, in separating the Mastodons which present this character from the genus Mastodon, under another generic head. I believe, also, that the presence or absence of a band of enamel on the superior incisors furnishes ground for the recognition of distinct generic groups, and would be so used in any other division of the Mammalia. It is often asked why it is necessary to multiply generic names on such grounds. My answer is simply an expression of the law governing the case, based on the supposition that when the species of animals and plants come to be fully known, the genetic series will be found to be uninterrupted, excepting by the presence or absence of characters which appear or disappear during the growth of a set of individuals, which we on this account call a species, or refer to a genus. The difference in the two cases consists in this: In the case of species, the characters are numerous and are matters of proportion, size, color, texture, etc., while in the case of the genus the character is single, and marks one step in the serial chain of structural modifications. In the case of the genus there is an actual addition or subtraction of some distinct

* Palæontological Memoirs of Falconer, i, p. 100, pl. 8.

† Loc. cit., ii, p. 15.

‡ Ossemens Fossiles, ii, p. 252, Ed. 1834: "Ann. Mus., 1806, viii, 272," teste Leidy.

part or piece of the organism.* If now we fail to notice these points or steps, we must abolish all genera. If we define some and fail to define others, our practice ceases to have the uniformity of a law, and we abandon the basis of scientific order.† One point, however, must be insisted on. In order that a character be usable for any purpose of definition, it *must define*. That is, it must belong to all the individuals referred to the species, genus, etc., defined, and must not be present in some individuals and wanting in others of those supposed to be defined by it. This being the case, adult animals only can be used for definition, as characters, especially generic, are added from time to time up to maturity. Sometimes only one sex can be considered, since the adult characters are in certain cases never reached by one sex or the other. This is often the case with insects. Moreover, some latitude for exceptional variations must be allowed. Thus, the exceptional absence of the last molar in a dog does not invalidate the definition of the genus Canis, M. $\frac{7}{8}$.

Of course, if all specimens of animals could be found, the definitions would all, or nearly all, be invalidated. But it is safe to assume that all the intermediate forms will not be found, so that the definitions of species will represent the state of our knowledge, and the results of the operations of nature in the preservation of individuals.

The case is somewhat different with regard to generic characters. As these involve the addition or subtraction of some part, having definite dimensions, it is quite possible to say when the latter is present or absent. Characters of this kind present the appearance of abruptness of transition, to which I have referred in my paper "On the Origin of Genera," and which gave rise to the formulation, by Professor Hyatt and myself, of the "laws of acceleration and retardation." When such change prevails throughout all the individuals of one or more species, a new genus has its origin. As a matter of fact, the creation of generic modifications has been exhibited, in the history of life, by many individuals nearly contemporaneously. As the change involves *but one character*, it offers a better opportunity for the formulization of the laws of evolution, than in the case of specific characters, which are more numerous.

The three genera of Elephantidæ, of which mention has been made above, will then be defined as follows:

Mastodon Cuv. Superior incisors without enamel band; inferior incisors wanting. Type *M. americanus*.

Dibelodon Cope. Superior incisors with enamel band; inferior incisors wanting. Type *D. shepardi*.

Tetrabelodon Cope. Superior incisors with enamel band; inferior incisors present in the male at least. Type *T. angustidens*.

To the genus Mastodon must be referred the following species. For

* See "Origin of Genera," Proc. Acad. Philada., 1869, where this point is discussed.

† American Naturalist, 1884, July, p.

the dental characters of the Indian species I am indebted to Messrs. Falconer and Lydekker:

Mastodon americanus Cuv., N. America.
" *?borsoni* Hays, E. and S. Europe.
" *mirificus* Leidy, N. America.
" *falconeri* Lydd., India.
" *arvernensis* C. & J., Europe.
" *sivalensis* Falc., India.
" *latidens* Clift., India.
Dibelodon shepardi Leidy, California, Mexico.
" *tropicus* Cope, Tropical America.
" *humboldtii* Cuv., South America.
Tetrabelodon angustidens Cuv., India, Europe, N. America.
" *andium* Cuv., S. America, Mexico.
" *productus* Cope, SW. N. America.
" *euhypodon** Cope, N. America.
" *pentelici* Gaudry, SE. Europe.
" *perimensis* Falc., India.
" *pandionis* Falc., India.
" *turicensis*† Schinz, Europe.
" *campester* Cope, N. America.
" *longirostris* Kaup, Europe.

The condition of the inferior incisors is unknown in the *Mastodon atticus* Wagner, and *M. serridens* Cope, and *M. proavus* Cope; and in some of the above species the presence of an enamel band on the superior incisors has not been established.

I may add that I do not perceive how the so-called genus Stegodon can be distinguished, as at present, by the number of crests of the intermediate molars, and by the presence of cementum. It will probably be necessary to look for other characters in order to sustain it.

DIBELODON SHEPARDI Leidy.

Mastodon shepardi Leidy, Proceedings Academy Philadelphia, 1870, p. 98; 1872, p. 142.

Mastodon obscurus Leidy part, Report U. S. Geol. Survey Terrs. I, p. 330, Plate xxi.

This species was originally proposed on the evidence of a last inferior molar tooth from Contra Costa county, California, and a part of a superior tusk from Stanislaus county in the same State. Dr. Leidy subsequently abandoned the species. I however revived it in a synoptic table of the species of North American Mastodons in 1884. ‡

The fossils of the Museum Nacional of Mexico, examined by me, included

* American Naturalist, 1884, p. 525.

† Von Meyer is my authority for the presence of mandibular tusks in this species, — *M. virgatidens* Meyer.

‡ American Naturalist, 1884, p. 524.

a well-preserved lower jaw of a Mastodon, which presents both rami, and both the last true molars, and the entire symphysis. In the collection of the Ecole des Mines I saw a palate with the second and third true molars of both sides in place, and the superior incisor teeth, or tusks. Other fragments of jaws, with numerous isolated molars, were seen in these collections and in that of the college of the city of Toluca.*

From these specimens it is clear that the high valleys of Mexico were inhabited by a trilophodont mastodon, with a short decurved toothless symphysis like that of the *Elephas primigenius*, and with a band of enamel on the superior incisor tusks. The molars have the characters of those of the *Mastodon andium* of authors, and are of about the same size. The cross-crests are divided at the middle line only, and one-half wears into a trefoil, while the other half wears into an oval, transverse to the long axis of the crown. The unworn crests are obtuse and not serrate; and there are no accessory tubercles besides those forming the lateral lobes of the trefoils. The size of the ramus and of the teeth is about that of the *M. angustidens*, and smaller than that of the *M. humboldtii*. The last inferior and last superior molars have but four cross-crests and a small heel. This I verified on several specimens.

A comparison of this species with those described, yields the following results: In the character of its molars it is identical with the *M. andium*, and differs from the *M. humboldtii* in the characters which distinguish the two species, as pointed out by Gervais.† That is, only one-half of each cross-crest wears into a trefoil, and the size is inferior. But it cannot be identified with the *Tetrabelodon andium*, because, according to Falconer,‡ that species possesses a long massive deflected beak containing an incisor tooth.‖ It is true that the specimen figured by Laurillard in D'Orbigny's voyage dans l'Amerique Meridionale, Pl. x, does not display a long beak and tusk, although the symphysis is much more pronounced than in the present species. But that plate is made from a drawing, and may thus be of doubtful authority. If correct, it may represent the female, or, as Falconer suggests, the young of the *T. andium*. The last inferior molar figured by Dr. Leidy, l. c., and formerly referred to a species under the name of *Mastodon shepardi*, has the character of the corresponding tooth of the Mexican species under consideration. The plate does not, however, represent the specimen satisfactorily in one respect. The trefoils are not sufficiently distinct, on account of the faint representation of their basal lobes. These nearly block up the cross valley, a fact not to be derived from an examination of the plate, but which is clearly seen in a cast preserved in the museum of the Philadelphia Academy of Natural Sciences.

* For the opportunity of examining the museum of this Institution I am much indebted to its President, Dr. Villada.

† In Castelnau's Expedition, 1855; Recherches sur les Mammiferes Fossiles de l'Amerique Meridionale, p. 14.

‡ Palæontological Memoirs, ii, pp. 226, 274.

‖ The lower jaw figured by Falconer, Mem. i, p. 100, from Buenos Ayres, as *M. audium* is clearly *M. humboldtii*.

This specimen also agrees with those in the Mexican museums in the small number of crests on the last inferior molar: four with a short rudimental heel. Another specimen of apparently the same species is described and figured by Leidy as having been brought from Tambla, Honduras.* This tooth is apparently anomalous in the contraction of the third cross-crest.

The range of this species may then be given as extending from California to the valley of Mexico, inclusive.

A species apparently allied to the *Dibelodon shepardi* is the *Mastodon serridens* Cope,† of which the typical specimen was brought from southwestern Texas. Premolar teeth of the same type were shown me by Professor Castillo, in the museum of the School of Mines. These came from a lignitic bed at Tehuichila, in the State of Morelos, of Loup Fork age. This epoch is indicated by the presence of the genera Protohippus and Hippotherium. The sharp, serrate edges of the crests distinguish the molar teeth from those of the *D. shepardi*, and as the species probably came from different horizons, they are probably distinct. A premolar mingled with those of *D. shepardi*, from the valley of Toluca, much resembles that of the *M. serridens*.

DIBELODON TROPICUS Cope, sp. nov.

Mastodon humboldtii? VonMeyer Palæontographica, 1867, Studien ueber das genus Mastodon, p. 64, Pl. vi. *Mastodon andium* Leidy, Proceedings Academy Philada., 1876, p. 38.

A second species of Dibelodon inhabited the valley of Mexico, of larger size than the *D. shepardi*, and differing somewhat in the dentition. Von Meyer describes and figures a ramus of a lower jaw, l. c., brought by Herr Uhde from Mexico, which has, according to Von Meyer, no mandibular tusk, and probably a short elephantine symphysis. A very similar ramus, containing the last molar tooth, was presented to the Philadelphia Academy of Natural Sciences by Dr. Isaac Coates, who obtained it from Tarrapota, on the Huallaga river, in Eastern Peru. The extremity of the symphysis of this specimen is broken away, but enough remains to show that it was probably short, and that there was no inferior incisor.

Reference to Von Meyer's figure shows that the last inferior molar has five well-developed cross-crests and a heel. The Peruvian specimen has the same character, the fifth cross-crest a very little more contracted than in Von Meyer's plate. Dr. Leidy describes the specimen as having four transverse ridges, besides a strong tubercular talon. But it seems to me that the talon is of such size as to be properly included in the cross-crests. On the same principle one might say that the *D. shepardi* has three cross-crests and a strong talon, as it has one less cross-crest than the *D. tropicus*. The additional cross-crest, and the superior size, distinguish this form as a species from the *D. shepardi*. Von Meyer perceived these differences, and referred his specimen to the *D. humboldtii*. I am fortunately able to

* Extinct Mammalia Dakota and Nebraska, Pl. xxvii, fig. 14.

† American Naturalist, 1884, p. 524.

make a comparison of his plate and the Peruvian jaw, with a well preserved jaw of the *D. humboldtii*, with perfect last molar and symphysis, from Buenos Ayres, in my collection. I am able fully to substantiate the characters already pointed out by Gervais, and to prove that the cross-crests of the molars form double trefoils, while those of the *D. tropicus* are like those of *D. shepardi* and the *Tetrabelodon andium*.

The species last named is said by Falconer (loc. sup. cit.) to occur in Mexico, and speaks of having seen a well preserved lower jaw from the State of Tlaxcala. I have not met with it.

The *Mastodon americanus* has not yet been found in Mexico. The most southern localities for the species known to me are Southern California, and near San Antonio, Texas. From the former region I possess a ramus with the last molar, presented to me by Mr. Scupham, of San Francisco; the other specimen was obtained from Mr. G. W. Marnock, of Helotes, near San Antonio, Texas.

ELEPHAS Linn.

ELEPHAS PRIMIGENIUS Blum.

This species, of both the thick and thin plated varieties, was once very abundant in Mexico. I have received a series of teeth from Candela, in the State of Coahuila, from Dr. Caspar Butcher, through my friend Dr. Persifor Frazer; and Von Meyer has pointed out the occurrence of its remains in the valley of Mexico. The museums of Mexico contain very numerous portions of skeletons of this species, which prove that it was far more abundant than the species of Mastodon. Up to this time this locality is the southern known limit of its distribution on the American continent.

APHELOPS Cope.

APHELOPS, sp. *Aphelops ? fossiger* Cope. Proceedings Academy Philadelphia, 1883, p. 301.

The right half of the mandible, with part of the symphysis of a rhinoceros, was found in the valley of Toluca, sixty miles west from the city of Mexico, and Dr. Barcena sent me a photograph of it a year ago. I published a notice of it as above cited, in connection with remarks on a rhinoceros skull which I obtained on one of the heads of the Gila river in New Mexico. On my recent visit to the College of Toluca, I had, through the kindness of Professor Viilada, the opportunity of examining the jaw. Its characters do not differ much from those of the *Aphelops fossiger* Cope. It is considerably smaller, and has a very short diastema, but not shorter than in some jaws of the *A. fossiger*. The dimensions are as follows:

Measurements.	M.
Length of ramus from base of canine	.400
" " dental series with canine, less M. iii	.235
" " molar series, less M. iii	.200
" " true molars, less M. iii	.105

Measurements.	M.
Diameter of canine (transverse)	.027
" of P-m. ii	.007
Depth of ramus at P-m. iii	.070
" " " at M. i	.085
" " " at front of M. iii	.090

The matrix in which this jaw was found, is much like the Upper Pliocene material of Tequixquiac. It is therefore of probably later age than the true *Aphelops fossiger*, which is a characteristic Loup Fork species. Leidy describes (Extinct Fauna of Dakota and Nebraska, p. 230) a rhinocerus, probably an Aphelops, from California, under the name of *R. hesperius*. It is smaller than the Toluca specimen, but has a considerably longer diastema. Its geological horizon is uncertain.

I mention here that rhinoceroses, probably of the genus Aphelops, apparently existed in North America during the Pliocene period. Bones of a species having resemblances to the *A. fossiger* have been sent me by my assistant, George C. Duncan, from the Equus beds of the eastern part of the Oregon desert. The genus has been hitherto supposed not to ascend higher than the Loup Fork, or Upper Miocene beds. These bones are accompanied by teeth of a peculiar Hippotherium unlike those of any species of the genus known to me from the Loup Fork Miocene.

EQUUS Linn.

The remains of horses are very abundant in the valley of Mexico,* and represent four species. In the determination of these species it has become necessary to compare them with those hitherto found in North and South America. In making this comparison I exclude the species of Hippidium, which are all American, and whose molar teeth are easily distinguished by the equality in size of the internal columns; resembling in this respect the genus Protohippus.

When the species of the genus Equus differ in the characters of their superior molar teeth, the diversity is to be seen in the size and form of the anterior internal column. The anteroposterior diameter of this column, as well as the integrity or emargination of the internal border of its section, varies according to the species. The infolding or the borders of the lakes has a value, but a less constant one. The *Equus caballus* differs from all of the American extinct species, where the corresponding parts are preserved, in the great elongation of the face, which is expressed in the greater lengths of the diastemata anterior and posterior to the canine tooth in both jaws. Other characters may be observed in the relative lengths of the limb bones, the form of the occiput, etc. It has been shown by Leidy, Rütimeyer and others, that it is not always practicable to distinguish the species of horses by their teeth alone. A glance at Owen's

* This fact has already been made known by Von Meyer, Palæontographica, 1867, p. 70, and Owen, Transactions of the Royal Society, London, 1869.

plates of the dentition of the existing species of Equus*, shows the truth of this statement. Among the extinct species of Equus the range of variation is greater.

The following attempt at a discrimination of the species known to me, or so fully described as to be well known, must necessarily be regarded as provisional, until the skeletons are more fully recovered. American extinct species only are introduced:

I. Long diameter of anterior internal lobe of superior molars not greater than one third the long diameter of the crown.

Borders of lakes crenate; internal anterior lobe notched on the inner side so as to be bilobate; crowns a little curved; large.....*E. crenidens.*

II. Long diameter of anterior internal lobe more than one-third and not more than one-half the anteroposterior diameter of the crown.

a Crowns more or less curved.

Crowns wider than, or as wide as long; enamel edges little folded..... *E. curvidens.*

aa Crowns straight or nearly so.

β Diastemata longer.

Crowns nearly square, enamel not very complex; no facial fossa; maxillary bone produced much beyond M. iii.....*E. caballus.*

ββ Diastemata shorter.

γ No facial fossa.

Crowns nearly square; enamel not very complex; maxillary bone little produced behind last molar; smaller..... *E. hemionus; E. burchelli; E. quagga; E. zebra; E. asinus.*

Crowns longer than wide on face; enamel little complicated; face and maxillary unknown; large.....*E. occidentalis.*

Crowns square; enamel more folded than in other species; face and maxillary unknown; large.....*E. major.*

γ A facial fossa.

Crowns nearly square; enamel less complex; maxillary short posteriorly; smaller.....*E. andium.*

III. Long diameter of anterior inner lobe more than half that of crown of molar teeth.

Crowns square; enamel little complex (in Mexican specimens); diastemata and maxillary behind shorter; no facial fossa; large...*E. excelsus.*

Crowns square; enamel little complex; smallest species.....*E. barcenæi.*

In using the above table it must be noted that gradations in the diameter of the anterior internal column (or lobe) exist, not only between individuals of the same species, but between different teeth in the same jaw. This diameter is always greatest in the last superior molar, and the characters of this tooth are such that they cannot be used in connection with the above table.

* Philosophical Transactions, 1869.

Before describing the Mexican species I make some notes on the others embraced in the above list:

Equus curvidens Owen. Of eight superior molar teeth from Buenos Ayres in my collection, two second premolars are perfectly straight, while the third true molar is the most curved. The other teeth exhibit different degrees of curvature. The area of the anterior internal column is not so flat on the inner side in any of them as in Owen's Plate (Voyage of the *Beagle*, Vol. i). My teeth have also a rather greater transverse diameter than Professor Owen's type.

Equus caballus L. The common horse differs from all of the extinct species of the genus from American localities where the muzzle is known, in the greater length of the latter, with its diastemata, of both jaws, and in the greater prolongation of the maxillary bone posterior to the last true molar. Appropriately to the anterior position of the molar series, the facial ridge commences above the middle of the first true molar. In an *Equus quagga* in my possession the ridge commences above the middle of the last premolar. The basioccipital bone is more compressed than in any species of the genus known to me.

Equus occidentalis Leidy. This species is represented in my collections by at least one hundred individuals, some of which have been lent me by my friend Professor Thomas Condon of the University of Oregon. They are nearly all derived from the Equus beds of the Oregon desert. Unfortunately there is no perfect skull. A few specimens from the same region I refer to the *Equus excelsus*, but as these are comparatively rare, I am safe in referring most of the bones to the other species. In these I find the following characters to separate the species from the *Equus caballus*: (1) The basioccipital bone is not compressed, and besides its inferior lateral angles it has a pair of lateral angles, one proceeding forwards from the inferior border of each *foramen condyloideum anterius*. (2) The fossa enclosed between the paroccipital process and the basioccipital, is deeper, and has a raised border in front which separates it strongly from the plane of the petrous bone. This is not found in *E. caballus*. I verify it in three separate occipital bones of the *E. occidentalis*. (3) The astragalus and other bones of the feet are smaller than in *E. caballus;* the first named intermediate in size between that of the horse and that of the quagga. The cannon bones, when of the same length, are more slender. (4) The inferior canine issues in direct contact with the last incisor, without the diastema seen in the horse; and the incisive arc is narrower and more produced. The symphysis is elongated not only forwards, but also posteriorly. The mental foramen is anterior to the bifurcation of the rami in *E. occidentalis*, posterior to it in *E. caballus*.

Equus major Dekay. Dr. Leidy leads us to infer (Report U. S. Geol. Survey Terrs., Vol. i, p. 244), that this species differs from the *E. occidentalis*, in the generally greater complication of the enamel folds. This I find to be the case in specimens from the Fish House, in the brick clay, near Philadelphia, and from the Big Bone Lick, Kentucky. Leidy

figures similar specimens from various parts of the Eastern and Southern States.

EQUUS CRENIDENS Cope, sp. nov.

This large species of true horse is represented by molar teeth and fragments of jaws belonging to two individuals preserved in the Museo Nacional of Mexico, and to two others preserved in the Escuela des Minas. The typical specimen includes the three premolars of the upper jaw of an adult in perfect preservation.

The species is primarily distinguished by the close and strong wrinkling of the enamel border of the lakes of the superior molar teeth. This wrinkling, or vertical plication, reminds one of what is seen in the *Elephas indicus*. This wrinkling is not found in the enamel edges which border the interior crescents on the inner side, nor in those bordering the internal lobes or columns. The borders of the lakes are not folded in the complex loops seen in *Equus major* Dek., but have the plainer looping seen in the *Equus tau* Ow. The grinding faces are nearly square. That of the second premolar is a rather shortened triangle, and less produced anteriorly than in the *E. tau*. The crowns of the third and fourth premolars are long and slightly curved.

The measurements show that this is one of the larger species of horse.

Measurements.		M.
Diameters of P-m. ii	anteroposterior	.0430
	transverse	.0305
Diameters of P-m. iii	anteroposterior	.0335
	transverse	.0340
Diameters of P-m. iv	anteroposterior	.0310
	transverse	.0350

The crimping of the enamel of the lakes distinguishes this species from the others of the genus.

From Tequixquiac.

EQUUS TAU Owen. Philosophical Transactions of the Royal Society, 1869; p. 565; pl. lx; fig. 4.

Of this species there are preserved in the Museum Nacional five superior molars, some of which belong apparently to one individual. In the Escuela des Minas, the series is a fine one. There are two skulls lacking the occiput; one skull lacking the occiput and muzzle; parts of both maxillary bones with teeth, of one skull; and a single maxillary bone with teeth, of a fifth skull. The specimen mentioned under the second head, has teeth and palate preserved, as in the figure given by Owen of his *Equus conversidens*, and I suspect it was from this specimen that the photograph was taken from which Professor Owen's figure and plate were made. It is possible that his figure and description of the *Equus tau* were made from one of the maxillary bones mentioned under head three. I am not able to perceive the specific differences between these specimens. The character displayed

by Owen's *E. conversidens*, on which he relied to distinguish the species, may be the result of distortion. The maxillary bones of the type are loose and may be made to assume different angles to each other. The last superior molar is represented as unusually short by Owen. This appearance could be produced by the oblique angle of the aperture of the camera in photographing, due to its too anterior position. Be that as it may, I could detect no specific differences between the seven or eight specimens I examined.

The *Equus tau* is an average horse in all respects, presenting no very tangible characters by which to distinguish it from the existing species of the *E. asinus* and *E. zebra* group, so far as the parts which I examined go. It has the internal anterior column of the superior molar always less in diameter than half that of the crown of the tooth, and not characterized by any marked peculiarity. The borders of the lakes have an entering loop on each end of the inner border; of these the adjacent ones are well marked, and the remote ones little marked. External to the adjacent loops the borders of the lakes are a little crenate. There is a small internal median loop of the internal enamel border at the notch. The crowns of the teeth are a little wider than long, and they are not curved. The palate notch reaches as far forwards as the posterior border of the second true molar, and the palatal foramen is opposite the front of the third true molar. The latter tooth is a little longer than the other true molars. The second premolar is short and robust. The diastemata are rather short, as can be seen by the appended measurements.

Measurements.	M.
No. 1. Escuela des Minas.	
Length of precanine diastema	.020
Length of postcanine diastema	.074
Length of molar series	.151
No. 2. Museum Nacional.	
Diameters of P-m. ii { anteroposterior	.030
Diameters of P-m. ii { transverse	.024
Diameters of ?P-m. iii { anteroposterior	.024
Diameters of ?P-m. iii { transverse	.027
Diameter of ?P-m. iv { anteroposterior	.025
Diameter of ?P-m. iv { transverse	.028

This species differs from the *Equus andium* Wagn., so fully described by Branco,* in the absence of a facial fossa. From *Equus caballus* it differs in the short diastemata, and the little posterior production of the maxillary bone. How it differs from the species of the *asinus* section I do not yet know.

EQUUS EXCELSUS Leidy, Extinct Mammalia Dakota and Nebraska, 1869, p. 266; pl. xxi, fig. 31.

*In Dames and Kayser Palæontologische Abhandlungen, 1883, p. 110, Dr. Branco furnishes reasons for believing that the *E. argentinus* Burm. is the same species

A portion of a left maxillary bone supporting the true molars of a horse from the Oregon desert, received from Professor Condon, resembles closely the type specimen from Nebraska described by Leidy as above. Two skulls, in the two museums of Mexico already referred to, present the same dental characters. In identifying the Mexican with the Oregon and Nebraska horses, I wish to be understood as making a provisional arrangement only, for unfortunately the cranium of the North American horse with this dentition is yet unknown. The uncertainty attending a dental identification being admitted, I proceed to the description.

This species differs from the others, whose remains have been found in the valley of Mexico, in the elongate and flattened form of the lobe formed by the section of the anterior internal column of the superior molar. This long diameter generally exceeds the half of that of the crown of the tooth by one-eighth the latter, and is rarely so short as one half of the same. The loops of the lakes are few, including only one near the posterior borders near the internal side and one on the anterior border of the posterior lake. There is generally a little loop at the notch between the two internal lobes. Crowns straight, second superior premolar elongate and acute.

One of the crania is complete, lacking only the lower jaw, and the two third true molars. The other lacks all posterior to the palatal notch. From the former I derive the following characters:

The apex of the nasal bones is above the superior canine tooth. The posterior border of the nares marks the middle of the anterior column of the third premolar. The infraorbital foramen is above the posterior edge of the second column of the fourth premolar. There are two notches on the anterior part of the superciliary border; and there is a short exostosis on each side of the front, in line with the supraorbital border, in front of the preorbital border.

Measurements.		M.
Length from superior edge of foramen magnum to incisive border		.565
From posterior nares to incisive border		.300
Interorbital width		.166
Length of series of molar teeth		.191
" precanine diastema		.022
" postcanine "		.056
Width of palate at third incisors		.092
" " canines, inclusive		.075
Diameters P-m. ii	anteroposterior	.0425
	transverse	.0275
Diameters P-m. iii	anteroposterior	.032
	transverse	.034
Diameters M. iii	anteroposterior	.0335
	transverse	.029

The internal anterior column of the superior molars is longer and flatter than in the specimens of the North American horse, but I do not feel at liberty to propose a new specific name for the Mexican animal. The absence of facial fossa and short diastemata throw it into the series of the asses. From all these the large flat internal column distinguishes it. The presence of the loop at the notch of the internal border in the Mexican specimens distinguish them from Leidy's type and from one of Condon's specimens. A second one of the latter has a small loop at the point in question. The absence of this loop is given by Leidy as characteristic of the *E. occidentalis*, but only a small proportion of my specimens of that species are without it.

The Mexican specimens are from Tequixquiac.

EQUUS BARCENÆI Cope, sp. nov.

Two superior molars represent this species in the Museum Nacional, and two superior molars in the Escuela des Minas. A skull lacking all in front of the orbits inclusive, in the latter museum, probably belongs to the same species.

This horse is distinguished from all the others here mentioned or described by its small size. In the characters of its superior molars it is like the *Equus excelsus*. The anterior internal column is flat, and its anteroposterior diameter is five-eighths that of the crown of the tooth. The prism is straight. The lakes have the margin but little looped; the posterior notch of the anterior lake is trebled or triplex. The grinding face of the crown of the third superior molar is a little longer than the others.

Measurements.		M.
Diameters of molar No. I	anteroposterior	.0215
	transverse	.0230
Diameters of molar No. II	anteroposterior	.022
	transverse	.022

From Tequixquiac.

I have dedicated this species to my distinguished friend Mariano de la Barcena, Professor of Geology in the National Museum and Director of the Meteorological Observatory of the City of Mexico.

PLATYGONUS Leconte.

PLATYGONUS ?COMPRESSUS Leconte.

A portion of the mandibular ramus of a species of peccary, apparently the above, was found at Tequixquiac, and is preserved in the museum of the College of Guanajuato. Dr. Alfredo Dugés, the distinguished professor in the college, called my attention to the specimen, and gave me a cast of it. Its dimensions are similar to those of North American individuals, as follows :

Measurements.		M.
Diameters of M. i	anteroposterior	.0145
	transverse	.012

Measurements.	M.
Diameters of M. ii { anteroposterior	.017
Diameters of M. ii { transverse	.014

HOLOMENISCUS, gen. nov.

Under the head of this genus I give a synopsis of the results of my study of the extinct Camelidæ of the American Pliocene epoch. I can compare the specimens from Buenos Ayres with those from Mexico and Oregon, and Branco and Owen have given detailed descriptions of specimens from Buenos Ayres and Mexico. From these sources I learn of the existence of the following generic forms of Camelidæ. I omit Protolabis Cope,* and refer it to a separate family—the Protolabididæ, on account of the presence of three superior incisors in each premaxillary bone, as in the primitive Ruminantia, combined with the presence of a cannon bone.

I. Premolar teeth $\frac{4}{4}$.

P-m. i separated by diastemata.....*Procamelus.*

II. Premolar teeth $\frac{3}{3}$.

P-m. ii below wanting.....*Pliauchenia.*

III. Premolar teeth $\frac{2}{2}$.

Fourth inferior premolar triangular..... *Camelus.*

Fourth inferior premolar composed of two crescents, which enclose a lake (an inferior P-m. 3?).....*Palauchenia.*

Fourth inferior premolar composed of two crescents, with two posterior tubercles behind them.....*Protauchenia.*

IV. Premolar teeth $\frac{3}{1}$

Fourth premolar below triangular..... .....*Auchenia.*

V. Premolar teeth $\frac{1}{1}$

Fourth superior premolar composed of two crescents.....*Holomeniscus.*

Fourth superior premolar consisting of a simple cone.....*Eschatius.*

The position of this genus being determined as above, it remains to examine the material representing it, at my disposal.

In 1873 Dr. Leidy† described a large species of llama from specimens from California, which include the entire inferior series of molar teeth, and one superior molar. The first inferior molar, properly the fourth premolar, has the crown partially worn, showing that it was opposed by a grinding tooth in the superior series. In the Museum Nacional of Mexico is preserved a complete mandibular ramus, containing all the teeth of one side of an animal smaller than Dr. Leidy's type, but having a general resemblance to it; including the worn fourth premolar. In the collections of Professor Condon and myself from the Oregon desert, there are various isolated molars agreeing in measurements with Dr. Leidy's type, and belonging probably to the same species. In the Condon collection is part

* Proceedings Academy Philadelphia, 1876, p. 145.

† Report U. S. Geol. Survey Terrs., F. V. Hayden, 1, p. 255, pl. xxxvii, figs. 1-3.

of a superior maxillary bone which contains the M. i and the alveolus of the P-m. iv, with the foramen infraorbitale anterius. The measurements of the M. i agree with those of the corresponding tooth of the lower jaw of Leidy's specimen. In the Museum of Mexico, there are preserved several superior true molars which also agree in dimensions with the corresponding teeth of the lower series of the type of the same *A. hesterna* of Leidy. The fourth superior premolar is wanting from this series.

The fragment of maxillary bone in the Condon collection shows that this species had a large three-rooted fourth premolar. It is broken off at the anterior alveolus, but it is so attenuated at that point as to make it almost certain that there was no third premolar in front of it, as is found in the genus Auchenia.

In further evidence of the existence of a genus characterized as above, by the absence of the P-m. 1, the jaw-fragment which represents the *Auchenia vitakeriana** may now be cited.

Holomeniscus vitakerianus Cope.

Although I ascribed a third superior premolar to this species, I must now deny its existence in the adult animal. A slight fossa on the narrow alveolar ridge indicates the possible presence of a single-rooted rudiment of such a tooth in the young. In a comparison of this species with the *Auchenia weddellii* Gervais, from the Pampean beds of Buenos Ayres, it is readily observable that the latter is a true Auchenia, with well developed P-m. 3 in the upper jaw, and that it is of larger and more robust proportions than the *H. vitakeriana*. In the only well preserved lower jaw which I possess, there is a well developed P-m. iii, a tooth found only as an occasional accident in *Auchenia lama* (teste Owen Odontography). In the *A. intermedia* Gerv., from the same locality, this tooth is wanting from one ramus, while the other displays a shallow vacuity as though such a tooth had existed in infancy and had been shed. I therefore retain these species in Auchenia.

HOLOMENISCUS HESTERNUS Leidy. *Auchenia hesterna* Leidy, loc. sup. cit.

The existence of superior molars in the Museum Nacional of Mexico which agree with the corresponding teeth of the Californian and Oregonian llamas has been mentioned above. I give the dimensions of these teeth as follows:

Measurements.			M.
Diameters M. i		anteroposterior	.041
		transverse	.033
Diameters M. ii	one individual.	anteroposterior	.041
		transverse	.040
Diameter M. iii	one individual.	anteroposterior	.053
		transverse	.029

* Bulletin of the U. S. Geological Survey Terrs., 1878, p. 380.

PROC. AMER. PHILOS. SOC. XXII. 117. C. PRINTED OCTOBER 22, 1884.

These molars are covered with a layer of cementum, which is included in the measurements.

The mandible, I am disposed to refer to a smaller variety of this species for the present. The well-worn fourth inferior premolar indicates that it could not belong to the genus Eschatius, where there is no opposing tooth in the superior series capable of producing such a result. The hook below the condyle is well developed in this jaw. The incisor teeth are narrow. The canine is small and is separated from the incisors by a diastema. The triturating surface of the fourth premolar is triangular, and includes a lake. The molars increase in size posteriorly. The mental foramen is large, and is situated behind a point below the canine.

Measurements.	M.
Length of jaw from incisive alveoli to angle	.415
Height at coronoid process	.290
" at condyle	.218
" ramus at M. i	.070
" " " middle of diastema	.040
Length of symphysis	.096
" from base of incisors to canine	.043
" " canine to P-m. iv	.092
" of all the molars	.147
Diameters P-m. iv { anteroposterior	.022
Diameters P-m. iv { transverse	.013
Diameters M. i { anteroposterior	.035
Diameters M. i { transverse	.019
Diameters M. ii { anteroposterior	.042
Diameters M. ii { transverse	.019
Diameters M. iii { anteroposterior	.048
Diameters M. iii { transverse	.016

From Tequixquiac.

A cannon bone in Condon's collection, which may belong to this species, measures fifteen and a quarter inches in length. So far as the evidence goes it may as well have belonged to the *Eschatius conidens*. According to Leidy the cannon bone of the *Auchenia californica* Leidy measures nineteen inches in length. A cannon bone of at least this size, with other bones of the skeleton, occurs in the museum of the School of Mines, and may belong to the Californian species. Whether that species is a true Auchenia or not remains uncertain, as the teeth are unknown.

ESCHATIUS, gen. nov.

This genus is well characterized by the reduction of the fourth superior premolar to a simple cone, in place of the usual double crescent characteristic of the Ruminantia generally. This is the greatest known reduction of the premolar series in the Ruminantia, exceeding anything in the Bovidæ, a family otherwise more specialized than the Camelidæ. If my

identification of mandibles be correct, there is but one inferior premolar, which is not prismatic, but has two divergent roots as in Auchenia. The crown is compressed. In any case this genus is distinct from Palauchenia Owen, which is said to have the fourth inferior premolar composed of two crescents, somewhat as in the Protauchenia of Branco. There is also a simple conic third inferior premolar according to Owen. The type specimen of the type of Palauchenia, *P. magna* Owen, consists of isolated teeth put together in a bed of plaster of Paris. While there may be some uncertainty as to the position of the third premolar, I cannot agree with Professor Leidy* in the supposition that these teeth have been inverted by their describer, and really belong to the upper jaw. The specimen is preserved in the museum of the School of Mines, and I did not observe any second one.

ESCHATIUS CONIDENS, sp. nov.

Primarily established on a superior maxillary bone, which contains all its teeth, which is preserved in the Museum Nacional of Mexico. I cannot distinguish from this individual another one which was found by Mr. C. H. Sternberg in the desert of Oregon, and which is represented by a good many fragments, including parts of both jaws. I describe the Mexican specimen first.

The true molars increase rapidly in size posteriorly. The vertical ribs of the external anterior horns of the external crescents are very strong, and the external wall of the anterior crescent has a low rib on the median line also. The posterior internal crescent of the last superior molar (which is not much worn) sends its anterior horn to the external wall, thus cutting off the posterior horn of the anterior internal crescent.

Measurements.		M.
Length of the four superior molars		.126
" " M. i		.041
Diameters of M. ii	transverse at base	.024
	anteroposterior	.044
Length of M. iii		.051

The *foramen infraorbitale anterius* issues above the anterior rib of the posterior crescent of the first true molar. The specimen is from Tequixquiac.

The Oregon specimen includes a left maxillary and mandibular bones, with the roots or alveoli of the teeth remaining, together with numerous bones of the skeleton. As one or two teeth of the *Holomeniscus hesternus* are mingled with the other pieces, it becomes uncertain to which of the species some of the bones should be referred. This is the more difficult, as the superior molar teeth of the two animals are of nearly the same dimensions. The probabilities are, however, that the greater number accompany the species represented by the jaws. I proceed to describe the latter.

In the maxillary bone the single alveolus of the fourth premolar is close

* Report U. S. Geolog. Survey Terrs. I, p. 256.

to that of the anterior root of the large first true molar. Its section is a wide oval. The base of the second true molar is not longer than that of the first true molar. The external wall of the maxillary bone is broken so that the position of the infraorbital foramen cannot be positively ascertained. A narrow groove, which may be a part of the infraorbital canal, is exposed, and is continued forwards to a point anterior to the first premolar, where it probably issues. If this be a correct inference, its position is anterior to that observed in the Mexican specimen. The palatine foramen issues opposite the anterior root of the first true molar. In the *Holomeniscus hesternus* this foramen issues opposite the fourth premolar's internal root.

The fragment of mandible is the anterior part of the left ramus, including the premolar and half the symphysis. The fundi of the anterior alveoli only are preserved. That of the canine is smaller than those of the incisor teeth, and is close to that of the external incisor. The mental foramen is large, and is situated posterior to the mouth of the alveolus of the canine. The symphysis is not coössified. The alveolar edge of the diastema is narrow, and presents a narrow vertical parapet outwards, which makes an angle with the external convex side of the ramus. The inferior outline below the diastema is a little concave. The roots of the premolar are well separated. The crown is lost. The coronoid process, supposed to belong to the same species, is like that of the llama, near the condyle, and is quite elevated. It maintains its anteroposterior width to near the summit. Anterior edge rounded, the bevel extending on the external face towards its base. The posterior rotula of the condyle is median, and not on one side as in the llama and in the camel. The anterior part of the face presents forwards as in the llama, and is not so much expanded as in the camel. The petrous bone is as large as that of the camel, and has a more widely open styloid fossa, which is directed more inwards in the downwards direction. The face also for the paroccipital process approaches much more nearly to its fundus than in either the camel or the llama.

Measurements.	M.
Long diameter of alveolus of superior P-m. iv	.009
" " " " M. i	.036
" " " " M. ii	.038
" " " inferior P-m. iv	.022
Length of inferior postcanine diastema	.070
Depth of ramus at middle diastema	.035
" " P-m. iv	.045

It still remains to be ascertained whether this Oregon Eschatius belongs to the species that is found in the Pliocene beds of the valley of Mexico.

Eschatius longirostris, sp. nov.

This llama is known to me from a right mandibular ramus, which is broken off behind the last molar tooth, and which supports the symphyseal portion of the left ramus, less its external wall. In size this species is be-

tween the *Auchenia weddelli* Gerv. and the *Eschatius conidens*, having just about the dimensions of the *Camelus dromedarius* or the *Palauchenia magna* Ow. It differs from the *Eschatius conidens* in the much longer inferior diastema, longer, coössified symphysis, and smaller true molar teeth; the comparison being made with superior molars of the *E. conidens*.

The alveolus of the inferior canine tooth is small, and is a short distance posterior to the third incisor, being separated by a short diastema. The mental foramen is very large, three times the size of that of the *E. conidens*, and its anterior edge is 20 mm. posterior to the canine alveolus. The alveolar parapet of the diastema is not so elevated as in *E. conidens*, but is distinct. The dentition shows that the animal is an old one. The fourth premolar has two divaricate roots, which spread nearly as far anteroposteriorly as those of the first true molar. The crown is compressed. Apex broken. The crowns of the molars are worn; that of the first to the roots. The heel of the third true molar is lost.

Measurements.	M.
Width of mandible at inferior canines	.027
Length of inferior postcanine diastema	.110
" " molar series	.132
" " P-m. iv	.027
" " M. i	.029
" " M. ii	.034
Width of " M. ii	.022
Depth of ramus at middle diastema	.043
" " P-m. iv	.058

From the Oregon desert; Professor Condon's collection.

BOS Linn.

Bos latifrons Harlan.

This species is represented by numerous remains, and must have been abundant in Mexico during the Pliocene epoch.

On the structure of the feet in the Extinct Artiodactyla of North America.

By E. D. Cope.

(*Read before the American Philosophical Society, August 15, 1884.*)

The structure of the feet of a number of the Artiodactyles of the Tertiary beds of North America has already been described. In this paper I enumerate these, and add descriptions of some types which have been hitherto unknown. I commence with the Bunodonta.

BUNODONTA.

Pantolestes Cope.

The structure of the tarsus only of this Eocene genus is known.*

* Cope, Proceedings American Philosophical Society, 1881, p. 188. Pal. Bulletin, No. 34.

The cuboid and navicular bones are distinct from each other and from the cuneïforms, and the ecto- and mesocuneïform are coössified. There are four metatarsals. The laterals (ii and v) are slender; and the medians are distinct but appressed, their adjacent sides being flattened. This foot structure is remarkably advanced considering the early age, Wasatch Eocene, of the period of its existence, and the primitive, tritubercular bunodont character of the superior dentition. The selenodont types which appear first in our series of formations, the Oreodontidæ of the White River low Miocene, present a much more primitive type of foot. The camel series is remarkable for the early and continued absence of the first and fifth metapodial bones. The first known of the line, Poëbrotherium, from the White River beds, has only minute rudiments of them. It is probable the Pantolestes, or some member of the Pantolestidæ, is an ancestor of Poëbrotherium, with a number of lost types intervening.

ELOTHERIUM Aym.

The first information respecting the structure of the feet of this genus was furnished by Marsh.* He says "The radius and ulna were separate or very loosely united. The third and fourth metacarpals were nearly equal in size, and the second and fifth longer than the corresponding bones of the pes. In the latter the first digit was wanting, and the fifth rudimentary." This description leaves us in the dark as to the development of the second digit in the posterior foot and of the second and fifth in the anterior foot. The ambiguous language led me to infer that there are four digits of the anterior foot of the animal described by Marsh, and hence to separate it generically from Elotherium. The first definite information is derived from Kowalevsky, from his great memoir on the genus Anthracotherium.† He here states distinctly that the genus is bidigitate, but with small rudiments of the second and fifth metapodial bones. He shows also that the lunar is equally supported by the magnum and unciforum. In a memoir especially devoted to this genus‡ he also shows that the cuboid, navicular and cuneïforms are distinct, while the ecto- and mesocuneïforms are coösified, the entocuneïform being absent. The structure of the tarsus in this genus is then as in Pantolestes, and from this genus or one of the same family, Elotherium no doubt took its origin through intermediate genera.‖

SELENODONTA.

OREODON Leidy.

We owe to Leidy the following statement regarding the foot structure of this genus.§ What are supposed to be the bones of the forearm and leg

* American Journal Sci. Arts, 1873, p. 487, June.

† Palæontographica, 1873, p. 188, August ?

‡ Loc. cit., xxii, N. F. JI, 7, p. 415.

‖ I have given the structure of the anterior leg and foot in *Elotherium imperator*, Bulletin U. S. Geol. Surv. Terrs., Vol. v, p. 60.

§ Extinct Mammalia of Dakota and Nebraska, 1869, p. 72.

are discrete, as in the hog; and the bones of the feet correspond in number with those of this animal. In 1873, Professor Marsh confirmed these statements as regards the metacarpal bones,* and added "that the navicular and cuboid bones were loosely coösified or separate." In 1884† I gave a full account of the structure of the limbs in this genus. I mentioned a peculiar feature of the carpus, viz.: that the os lunare is supported below by the inward extension of the unciform, so that the magnum is below the scaphoideum. I also showed that the cuneïforms are distinct, and that the entocuneïform is wanting.

EUCROTAPHUS Leidy.

I have already stated that this genus is tetradactyle anteriorly and posteriorly.‡ I now add that the structure of the limbs and feet is in other respects like that of Oreodon. This is true of the inner extension of the unciform, so that the magnum is below the trapezoïdes. The inner side of the latter bone in the *Eucrotaphus pacificus*, is so excavated, that there was plainly a free trapezium of small size. In the posterior foot the entocuneïform is wanting, and the mesocuneïform is distinct from the ectocuneïform.

MERYCOCHŒRUS Leidy.

The first information of the foot structure of this genus is contained in my paper on the Oreodontidæ above cited.‖ The fore and hind feet are there stated to be tetradactyle. I now add that in the *M. montanus* Cope, the os magnum is entirely below the scaphoid, and that there is a distinct trapezium. The posterior foot is constituted as in Eucrotaphus; I also observe that the navicular has a peculiar little facet on its distal face near the front of the external edge. This fits a corresponding facet which forms the proximal surface of a ledge, which extends from front to rear on the inner side of the cuboid. In *Eucrotaphus pacificus* the arrangement is similar, excepting that the ledge of the cuboid is interrupted at the middle by a deep excavation. In *Merychyus arenarum* the cuboid is like that of *Merycochœrus montanus* in regard to this ledge.

MERCHYUS Leidy.

The limbs and feet in this genus are quite as in Merycochœrus. The species which I have examined is the *M. arenarum* Cope.

LEPTOMERYX Leidy.

We possess as yet no information regarding the limbs and feet of this genus. It is therefore fortunate that I obtained in the White River bed of North Eastern Colorado, in 1879, a nearly entire skeleton of the *L. evansi* Leidy. The bones were all found close together, and belong to two individuals, and are without admixture of those of any other species.

* Amer. Jour. Sci. Arts, p. 409; Marsh does not credit Leidy with his previous observations.

† Proceeds. Amer. Philos. Society, Pal. Bulletin, No. 38, pp. 508–10.

‡ Loc. cit., p. 504.

‖ Proceeds. Amer. Philos. Society, 1884, p. 504.

From these, and inferentially from other specimens, is derived the curious fact, that there are four distinct metacarpals, all supporting digits, while there are but two metatarsals, which are coösified into a cannon bone. This diversity between the limbs is unparalleled, although an approach to such a condition is seen in the peccary. In this animal, as is well known, there are four distinct digits in the manus, while in the pes, the metatarsals are coössified proximally, and the fifth metatarsal is reduced to a scale. This difference between the two limbs is a further illustration of Mr. Ryder's statement that the posterior limb is in advance of the anterior in grade of development, for which I have endeavored to account by reference to the fact that it is the posterior foot which receives the greater number of impacts in progression. This is because the hind limb is the principal propeller of the body.

In accordance with the structure of the feet, the fore-limb is much behind the posterior limb in the fixity of its parts. The ulna and radius are distinct; the head of the latter a regular transverse oval. The distal extremity of the fibula is not coössified with the tibia, but forms a separate bone, as in the Ruminantia.

The lunar is mainly supported by the unciform, so much so that the front face of the magnum is not beveled to fit the former. Behind the face, the edge of the magnum is a little beveled for the lunar; but the former bone lies almost entirely under the scaphoid. The trapezoïdes is coössified with the magnum. No distinct trapezium.

The cuboid and navicular are solidly united. The ecto- and mesocuneïforms are distinct, and there is no entocuneïform. The second metatarsal is represented by a flat oval bone which is borne on the underside of the projecting heel of the third metatarsal. The fifth is of smaller size, and is a scale imbedded in a depression of the posterior part of the side of the fourth. Ungues unilateral, trihedral and acute.

HYPERTRAGULUS Cope.

Remains of this genus are as abundant in the White River beds as are those of Leptomeryx, and like that genus I know but the one species, the *H. calcaratus* Cope. Unfortunately I have not been able to obtain bones of the skeleton connected with dentition from this formation, although numerous bones occur separately which probably belong to it. The genus is however abundantly represented in the John Day Miocene beds of Oregon, where Leptomeryx does not probably occur. At least no specimens of the latter are to be found in a collection of between one and two hundred individuals of this general type in my collection. I cannot distinguish the John Day species from the *H. calcaratus*, although the size is generally distinctly larger.* In other cases the size is the same. To the John Day specimens then I refer for the characters of the feet of this genus.

* It is probably this species that is cited by Leidy as the *Leptomeryx evansi* in the Report U. S. Geol. Survey Terrs. I, p. 216.

The ulna and radius are coösified. The scaphoid and lunar facets of the radius are well distinguished by an oblique ridge. The carpus is unknown. The median metacarpals are separate; whether the second and fifth are well developed I do not know, but suspect them to be so, as in Leptomeryx, since the third and fourth bear no adherent rudiments. The cuboid and navicular bones are united, while the cuneïforms are distinct from them and from each other, as in Leptomeryx. There are but two developed metatarsals, and these are distinct from each other. Thus the fore-limb in its ulno-radius exhibits a little advance over Leptomeryx; while in the separate metatarsals it is behind the latter.

HYPISODUS Cope.

This genus is remarkable for its prismatic dentition, being the only Artiodactyle presenting the character in the White River fauna.* It was probably well advanced in foot characters, but of these I know but little. Parts of two tarsi found with the jaws of the *H. minimus* Cope, are referred to the species on account of their very small size, and general correspondence. The cuboid and navicular are coössified. Their distal face, especially the navicular part, is so narrow transversely, that it is almost certain that the third and fourth metatarsals are coössified, and that the second and fifth are rudimental or wanting. There is no trace of facets for the latter on the naviculo-cuboid.

POËBROTHERIUM Leidy.

I have fully described the limbs of this genus in the Annual Report of the U. S. Geological Survey of the Territories for 1873†, as seen in the *P. wilsoni* Leidy, from the White River beds, and have confirmed them from a fine specimen of the *P. sternbergi* Cope, from the John Day or Middle Miocene of Oregon.‡ The characters are; ulna and radius coössified; trapezium and trapezoïdes present and distinct; magnum supporting part of lunar. Two distinct metacarpals, scales representing the second and fifth; navicular and cuboid bones distinct, as are the ecto- and mesocuneïforms; entocuneïform wanting. Metatarsals two, distinct; second and fifth represented by scales.

OBSERVATIONS ON THE PHYLOGENY.

I have maintained ‖ that the selenodont dentition is a derivative of the bunodont, a proposition which seems unavoidable from a mechanical point of view. The testimony of palæontology is also in its favor, since in America the oldest artiodactyle, Pantolestes, is bunodont. Kowalevsky in the phylogenetic table given in his monograph of Anthracotherium§ does

* See Cope, Annual Report U. S. Geological Survey Terrs., 1873, p. 501, where the cuboid and navicular are stated to be united.

† 1874, p. 499.

‡ Bulletin U. S Geol. Survey Terrs. V, p. 59.

‖ Journal Academy Natural Sciences, 1874. See also Ryder, The Mechanical Genesis of tooth forms, Proceeds. Academy Philada., 1879, p. 47.

§ 1873 (?4), p. 152.

not commit himself as to this point, but allows the development of the two types of dentition to appear to have been cotemporary and from some common origin. He then derives from such a common point of departure first, the Hyopotamidæ, which first appear in the Eocene, and second, the ancestors of the Anoplotheriidæ. From the Hyopotamidæ he derives all the modern Selenodonta, exclusive of the Camelidæ. The latter group he omits from his table, doubtless because his information on the subject was insufficient. The main line of origin of the Selenodonta is divided early in Miocene time, the genus Gelocus giving origin to the Pecora, and the genus Hyæmoschus to the Tragulina.

In describing the characters of the genus Poëbrotherium for the first time, I remarked as follows :* "The present genus is a more generalized type than Gelocus, and in its distinct trapezoïd and distinct metacarpals represents an early stage in the developmental history of that genus. It also presents affinity to an earlier type than the Tragulidæ which sometimes have the divided metacarpals, but the trapezoïdes and magnum coössified. In fact Poëbrotherium as direct ancestor of the camels, indicates that the existing Ruminantia were derived from three lines represented by the genera Gelocus for the typical forms, Poëbrotherium for the camels and Hyæmoschus for the Tragulidæ."

These views being then established on sufficient evidence, it remains to make such additions as the facts cited in the present paper indicate. First in importance comes the place in the phylogeny of the Selenodonta, of the Oreodontidæ. The peculiar inward extension of the unciform bone already ascribed to them, characterizes also among extinct forms the genus Leptomeryx, and probably Hypertragulus. Among recent ruminants it is only seen in the Tragulidæ.† If we arrange these types in serial order we find the modifications of form to be generally identical with those of the other ruminant lines, in the coössification of the bones of the legs and feet. This series may then be regarded as phylogenetic. The peculiar structure of the carpus of the Oreodontidæ, puts them out of the question as ancestors of any type of existing ruminants other than the Tragulina. Whether they themselves can be traced to a five-lobed, or to a four-lobed bunodont ancestor, remains an undecided question. It is not, however, probable that a five-lobed form has been intercalated in a series, both of whose extremities are four-lobed. If this be true, the Oreodontidæ must be regarded as an ancestral type of Selenodonta, coëqual with the Hyopotamidæ, and it may well be questioned whether the latter can have been ancestors of the existing Ruminantia, whose molars are four-lobed.

So the present investigation does not disclose the ancestral stock of the Pecora. In North America we have not progressed further in the solution of this question than I reached in 1877,‡ after a study of the genera

* Bulletin U. S. Geol. Survey Terrs. Vol. i, No. 1, p. 26, Jan., 1874.

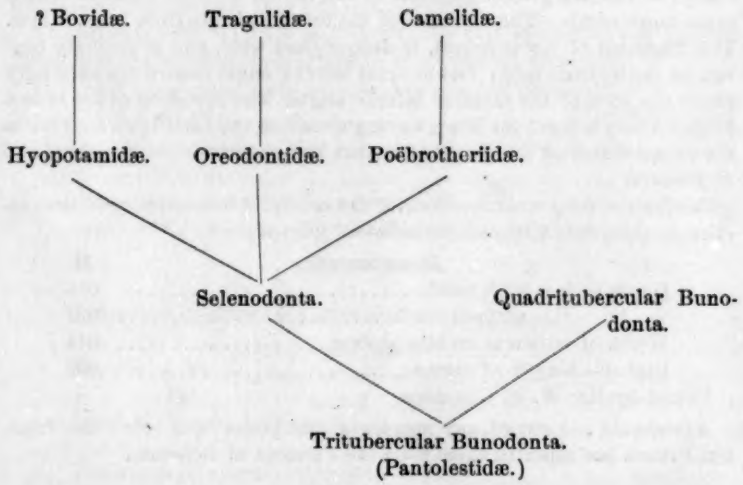
† Among Perissodactyles it occurs in Triplopus, Tapirus and the Rhinocerontidæ.

‡ Proceedings Amer. Philos. Soc., p. 223.

Cosoryx Leidy, and Blastomeryx Cope. I had already* suggested that the former genus is the ancestor of the Cervidæ, but subsequently† remarked: "It is not probable this genus is the immediate ancestor of Cervus, from the fact that the molar teeth display in their prismatic form a higher degree of specialization than belongs to that genus. It is probable that the true ancestor combined the dental type of Cervus with the distinct roots and short crowns of the molars, with the type of horns here described." I at that time included a species (*Cosoryx gemmifer* Cope) in the genus, provisionally, which has the type of molars in question. Having discovered another, larger species, which has the same type of molars, I at once distinguished the provisional group in which I had placed the *C. gemmifer*, Blastomeryx, as a genus; and in describing the species (*B. borealis*) observed as follows:

"In brief, its molars differ from those of Cosoryx ("Dicrocerus") much as those of the deer differ from the molars of the antelope. While Cosoryx ("Dicrocerus") was probably the ancestor of Antilocapra, Blastomeryx was the ancestor of Cervus or Cariacus." This opinion expresses all the information I possess on the subject at present. It remains to ascertain the structure of the anterior feet in Hypisodus, which is the earliest genus of Ruminantia known to have prismatic molars.

The following table will represent the views expressed in the preceding pages:



* Proceedings Academy Philadelphia, 1874, p. 149.

† Report Expl. Surv. W. of 100th Mer. U. S., G. M. Wheeler in charge, iv, pt. ii, p. 349, 1877.

*Fifth Contribution to the Knowledge of the Fauna of the Permian Formation of Texas and the Indian Territory. By E. D. Cope.**

(*Read before the American Philosophical Society, August 15, 1884.*)

PISCES.

CERATODUS FAVOSUS, sp. nov.

This species is known to me from a piece of the lower jaw, which supports a tooth. One extremity of the tooth is broken off, but from the curvature of its inner side, it is to be inferred that the portion lost is but small, probably including one of the three processes which the tooth possesses. The species may be distinguished from those described by Agassiz, and from the existing species, by the great depth of the two emarginations of the external side. These enter the crown so deeply as reduce its width to dimensions no greater than those of each of the processes of the crown. The internal face is strongly convex, and one extremity is more strongly recurved than the other. The crown consists of a mass of coarse perpendicular simple calciferous tubules, which are enclosed in a rather thin layer of a dense substance which thickens downwards, and laps over the external face of the jaw bone. The external surface of this layer is vitreous. The walls of the tubules are of a dense and hard substance, of a darker color in the fossil, and the tubules are filled with a softer substance, so that the grinding surface of the crown has the appearance of a small honeycomb. The diameter of the tubules ranges from 1. to .05 mm. The fragment of jaw is robust, is deeper than wide, and is strongly convex on the internal face. The internal inferior angle rises at one extremity above the level of the external inferior angle. The processes of the crown project freely beyond the bone, having rested on the cartilage which forms the external face of the jaw, as Günther has shown to be the case in the *C. forsteri*.

Besides the deep emarginations of the crown, the coarseness of the calciferous tubules is a special character of this species.

Measurements.	M.
Depth of jaw with tooth	.019
" " without tooth	.012
Width of crown at middle process	.014
Probable length of crown	.022

Found by Mr. W. F. Cummins.

Agassiz did not record any species of this genus from below the Trias, but Fritsch has reported them from the Permian of Bohemia.

BATRACHIA.

CRICOTUS CRASSIDISCUS, sp. nov.

Accession of additional material enables me to add several points to the

* The "Fourth Contribution" will be found at page 628 of these Proceedings for the year 1883.

knowledge of the osteology of this genus, and to distinguish satisfactorily three species. I have much pleasure in obtaining these additional facts, since everything relating to this curious genus is of interest.

In the first place, the neural arches are not coössified to the centra, but are readily separated from them. Their basis of attachment forms, on each side of the median neural canal, an oblique triangular surface looking forwards and upwards, with the apex above and behind. The ease with which the neural arches separate accounts for the rarity of their occurrence on separate centra. They support the diapophyses at their lower border. Second, that the sacrum consists only of a centrum and an intercentrum, both of which take part in furnishing a concave facet for the attachment of the pelvis. Third, some of the ribs are two-headed, and their capitular articulation is with the posterior edge of the intercentrum. Fourth, there is a hyposphenal articulation, as in the genera of Jurassic Saurians, Camarasaurus, Amphicœlias, etc., and in the Permian genus Empedias, among the Theromorpha. The hypantrum has, however, this peculiarity: that its sides are produced forwards into a process on each side below the prezygapophyses, each of which is subconical in form, but with the interior face excavated to receive the hyposphen, so that the section of the process is crescentic. These processes I have never previously observed. I call them hypantrapophyses. I find them in the *Cricotus hypantricus*. The neural arches of the other species are either lost or in such close juxtaposition that I cannot see them.

The species differ in part as follows; the full characters can only be given in more detailed descriptions of more perfect specimens.

I. Dorsal intercentra much narrowed or pinched above.
Hypantrum unknown..... *C. heteroclitus.*

II. Dorsal intercentra equally robust above as below, or more so.
Hypantrum unknown..... *C. crassidiscus.*
Hypantrum with acute lateral processes..... *C. hypantricus.*

The measurements of the *C. crassidiscus* are as follows:

Measurements.		M.
Diameters of dorsal centrum behind	vertical	.025
	transverse	.025
Length of do.	middle line below	.013
	at base of neural arch	.013
Base of neural arch	width	.010
	length	.009
Diameters of a dorsal intercentrum	vertical	.025
	transverse	.025
Length of do.	middle line below	.009
	" " above	.0095
Diameters of coracoid	transverse length	.027
	width at glenoid face	.029
	width at internal face	.010

It is probably this species which I have figured in the Proceedings of the American Philosophical Society,* and American Naturalist,† under the name of *C. heteroclitus*. It is the most abundantly represented in my collection. In the specimen figured in the American Naturalist, the probable scapula is visible on both sides, but the coracoid is concealed by the pectoral scuta.

CRICOTUS HYPANTRICUS, sp. nov.

This Embolomere is probably represented by two individuals, which are of larger size than any species which have hitherto come under my notice, one of them very much larger. It is only the smaller specimen which is accompanied by the astragalus. Both of them display the hypantrapophyses already mentioned in remarks on the genus under the head of *C. crassidicus*.

As already pointed out in the key of species, the dorsal intercentra in the *C. hypantricus* are stout and not narrow above, but the thickness increases rather than diminishes upwards. They thus differ from the corresponding intercentra in the *C. heteroclitus*. In many of the dorsal intercentra the dense external layer which covers the inferior face continues upwards to an apex, the articular surfaces of the two ends meeting so as to exclude the former. This is also the case in the *C. crassidiscus*. The centra have the abbreviated form characteristic of the genus, and the foramen chordæ dorsalis is present, but is smaller than the *C. heteroclitus*.

The supposed astragalus is oblong; proximal‡ border longer than the distal, which is separated by an obtuse angle from the ectad; distal entad not reaching superior surface of bone, long, extending inwards below the revolute proximal part of the entad face, from which it is separated by a narrow oblique groove. Proximal and distal entad separated by notches of the two faces; a ridge the length of the bone below.

Measurements.		M.
Diameters of centrum of individual with astragalus.	anterposterior	.015
	transverse	028
Diameters of astragalus	anterposterior	.038
	transverse	.029
Diameters of centrum of larger individual.	anteroposterior	.018
	transverse	.038
Diameters adjacent intercentrum of do.	anteroposterior	.013
	transverse	.038

REPTILIA.

CLEPSYDROPS LEPTOCEPHALUS, sp. nov.

This species is represented by almost the entire skeleton, the principal deficiency being that of the scapular arch and the anterior limbs, with the

* 1881, pl. ii, figs *a–b*.

† 1884, p. 39, pl. v and fig. 7. In pl. v, figs *f* and *g* represent the *C. heteroclitus*.

‡ I determine the ends of this specimen from a foot of Eryops.

phalanges of the posterior feet. The bones of the skull are mostly preserved, but in a dislocated condition. They serve to demonstrate some of the characters of the genus and family.

The quadrate bones of both sides are distinctly displayed. They are rather short, and articulate above by squamosal suture with the squamosal bones, which overlap them posteriorly. They narrow upwards, and are deeply grooved on the anterior face below. Each edge of the groove is produced forwards; the external for a considerable distance as an acuminate laminiform process, in the usual position of a quadratojugal bone. The production of the internal edge is shorter, and its extremity is vertically truncate. Its superior edge fits an incurvature of the superior edge of the pterygoid bone, and its internal face is applied to the external face of the latter.

The pterygoid bone displays the subtriangular plate with dentigerous edges, such as I have already described as present in the species of Dimetrodon. In this species it is thinner and less massive than in any species of that genus yet known. This specimen enables me to locate it more precisely than heretofore. The pterygoids were probably placed much as I have represented them to be, in the *Empedias molaris* Cope (Proceedings American Philosoph. Society, vol. xix, p. 56, pl. v). They send inwards a subtriangular plate from each side, which approach each other on the median line without touching, and the adjacent edges are somewhat decurved. The posterior edges are deeply concave on each side of the middle line, and like the inferior edges, are dentigerous. The process for the quadrate extends outwards and backwards, and is thickened on its posterior edge, while its anterior edge, which is continued from the inferior edge of the posterior border, becomes very thin. The anterior production for the ectopterygoids extends outwards and forwards, leaving the anterior edge of the dentigerous plates as the concave posterior border of the large palatine foramina. The anterior production of the internal edge of the plate becomes very thin, and is broken in the specimen without showing articulation for the palatine.

The squamosal extends both above and below its anteriorly directed zygomatic portion. The superior extremity shows squamosal suture for the parietal.

The stapes is of large size. It consists of a stout rod terminating in a double extremity, something like the double head of a rib. The shorter head is expanded into a funnel shape. Near to it the shaft is perforated in the longer diameter by a foramen. The extremity of the other head is transversely truncate and is separated from the funnel by a deep notch. On the outer side of the fundus of this notch, a foramen penetrates the shaft obliquely and is continued into a canal which issues at the foramen first described. The distal end is truncated by an irregular sutural surface. In the specimen the bone lies behind the squamosal and quadrate bones, the simple extremity of the rod near the posterior edge of the quadrate.

The premaxillary bones are distinct. The teeth of that bone and of the maxillary are of unequal sizes.

The axis has an expanded neural spine, and a diapophysis for rib articulation, but no parapophysis or capitular fossa. The two latter features characterize all the vertebræ which follow, as far as the lumbar series.

The column in the typical specimen is tolerably complete, with a break of uncertain, but probably not great length in front of the sacrum, and the loss of the distal part of the caudal series. Intercentra of rather small size are present throughout the series anterior to the sacrum. The inferior faces of the caudal vertebræ are yet concealed by matrix. The bases of the neural spines are compressed; they were probably not elongate as in Dimetrodon, though they are unfortunately broken off, except that of the third cervicodorsal vertebra. Here the spine is short and truncate above, and rather wide anteroposteriorly. As in Dimetrodon there is no distinction between cervical and dorsal vertebræ.

The pelvis is well preserved, and has the characters already assigned to the *C. natalis* Cope.* The ilium has a process or narrowed continuation with parallel sides, directed backwards and upwards, and bearing a keel on the middle line on the internal side. The ischia are much produced posteriorly, and are separated by a notch on the middle line posteriorly.

The head of the femur is expanded, including probably the homologue of the great trochanter of mammalia, and its articular face is crescentic, with obtuse horns. There is a trochanter below it on the posterior edge of the shaft. The condyles are inferior, and are separated by a deep groove above and a shallow one below. The articular faces of the two condyles are continuous, forming and ∞-shaped figure. The proximal extremity of the tibia is wider than the distal, and the articular face is uninterrupted. That of the distal extremity is a transverse oval.

Specific characters. While the vertebral centra of this species are rather short, the bones of the head are very much attenuated, and the jaws are long and slender. None of the four jaws is prefectly preserved, but the number of the teeth in the maxillary bone may be approximately fixed at thirty in a continuous series. One, and probably two of these, placed near the anterior part of the series, are larger than the others. They are placed at the position of the corresponding large maxillary teeth in Dimetrodon, but they do not display the dimensions seen in the species of that genus. To strengthen the jaw at this point, a rib rises from the thickened alveolar portion, and extends vertically on the inner side of the thin facial plate of the bone. The facial plate is double, and each lamina, except at the rib, is not thicker than wrapping paper.

The premaxillary bones are robust, and are excavated postero-laterally for a very large nostril on each side. The spine is long. The alveolar edge bears five teeth, which are followed by a diastema. These diminish in size posteriorly, the first one being the largest, and equaling the large

* Proceeds. Amer. Philos. Society, 1878, p. 509.

maxillary teeth. The last two are quite small, less than the usual maxillary teeth.

The dentary bones are very slender, and the distal end is somewhat thickened to support two teeth larger than the others. These are the third and fourth from the extremity, and are not quite so large as the large teeth of the maxillary bone. The remaining mandibular teeth are small, and are not so much compressed as in the species of Dimetrodon. Many of them have only a posterior cutting edge, which is not denticulate. The apices are strongly turned backwards in the posterior part of the series. The posterior part of the dentary bone rises and carries some of the teeth with it.

The surface of the free edge of the internal plate of the pterygoid bone is granular. The teeth on the posterior edge of the same are subconic, and in a single series.

There are twenty-seven vertebræ in a continuous series, from and including the axis. All bear diapophyses, and all are rib-bearing, except perhaps the last two, where they are of reduced size. They are more or less opposite the neural canal as far as the twenty-second centrum. On this vertebra the superior edge is on a level with floor of the canal, and posterior to this point the diapophyses rise from the centrum. Two sacrals and ten caudals are preserved, and all have diapophyses and neural spines. The centra in this species are rather short, being as deep as long throughout the series, if measured at the middle. The edges are not undulate as in *C.* (*Embolophorus*) *limbatus* Cope. The intercentra are short and not extended upwards on the sides as in that species.

Measurements.	M.
Length of quadrate bone	.085
Width of condyle of quadrate bone (greatest)	.037
Length from condyle of internal anterior process of do.	.032
" " " external " " "	.097
" of squamosal bone (vertical)	.124
" " pterygoid from palatal foramen	.116
Width " " at middle	.090
Length " internal dentigerous edge of do	.070
" " posterior " " "	.051
" " maxillary bone posterior to canine brace	.181
Thickness of " " at canine brace	.020
Depth of " " " nostril	.016
Length of premaxillary bone (posterior apex restored)	.000
Width " " " at third tooth	.022
Diameter of large (first) premaxillary tooth	.008
" " " maxillary tooth (canine)	.009
" " small " "	.006
Length of crown of last maxillary tooth	.009
" " twenty-seven continuous cervico-dorsal vertebræ	.855

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Measurements.	M.
Length of two sacrals	.65
" " ten caudals	.260
Diameters centrum axis: anteroposterior	.034
Diameters centrum axis: vertical posteriorly	.031
Diameters centrum axis: transverse posteriorly	.030
Elevation of neural spine from centrum	.071
" " arch " "	.009
Width of postzygapophyses	.030
Elevation of neural spine of fourth vertebra	.058
Diameters centrum sixteenth vertebra: anteroposterior	.025
Diameters centrum sixteenth vertebra: vertical at end	.035
Diameters end centrum seventeenth centrum: vertical	.034
Diameters end centrum seventeenth centrum: transverse	.030
Expanse of postzygapophyses of seventeeth vertebra	.029
Diameters twentieth centrum: vertical at end	.031
Diameters twentieth centrum: anteroposterior	.027
Diameters of twenty-ninth centrum: anteroposterior	.024
Diameters of twenty-ninth centrum: transverse behind	.035
Expanse of postzygapophyses of twenty-ninth vertebra	.024
Width of sacrum through fixed diapophyses	.049
Diameters centrum twentieth caudal: anteroposterior	.025
Diameters centrum twentieth caudal: vertical behind	.0265
Diameters centrum twentieth caudal: transverse "	.0225
Expanse through diapophyses	.047
Elevation of prezygapophyses (greatest)	.039
Diameters of pelvis: anteroposterior (apex of pubis restored)	.235
Diameters of pelvis: vertical through acetabulum	.123
Anteroposterior diameter of ilium at acetabulum	.089
Depth of ischium at posterior edge of acetabulum	.080
Length of " from acetabulum	.117
Length of femur	.179
Proximal diameter of femur: anteroposterior	.075
Proximal diameter of femur: transverse (at middle)	.025
Diameters shaft at middle: transverse	.038
Diameters shaft at middle: anteroposterior	.031
Diameters of distal end: transverse	.068
Diameters of distal end: anteroposterior external condyle	.031
Diameters of distal end: anteroposterior internal "	.045
Length of tibia	.150
Diameters of tibia: proximal anteroposterior (middle)	.040
Diameters of tibia: proximal transverse	.057
Diameters of tibia: median anteroposterior	.019
Diameters of tibia: distal anteroposterior	.026
Diameters of tibia: distal transverse	.041

The typical specimen of this species was found by Mr. W. F. Cummins in the Permian beds of Northern Texas.

CLEPSYDROPS MACROSPONDYLUS, sp. nov.

This species, like the last, much exceeds the *C. natalis* in dimensions. The bases of the neural spines are enlarged, so that it is probable that the spines were not elongate as in the species of Dimetrodon. Intercentra are present throughout the dorsal and caudal series of vertebræ. The dentary bone supports one or two large teeth near the extremity. These characters furnish the reasons for referring the species to the genus Clepsydrops.

The individual by which the species is known, is represented by an axis vertebra, twelve continuous dorsal vertebræ; nine other continuous vertebræ, of which three are lumbar, two sacral, and four caudal. Also by a part of the ilium, and by the greater part of a dentary bone. All of these specimens were found together, and possess an identical mineral appearance.

That this reptile belongs to a distinct species from the *C. leptocephalus* is readily determined by the form of the dorsal vertebræ. The centra are a little longer than those of that species, but have a smaller vertical diameter. The latter is three-fifths of the former, while in the *C. leptocephalus* the two dimensions are reversed, the depth being a little in excess in corresponding parts of the column. The dentary bone, on the contrary, is more robust than that of the *C. leptocephalus*, and supports, probably, a small number of teeth.

The edges of the centra are not undulate or laterally flared. The centra are strongly compressed, and in the anterior part of the column have an obtuse hypopophysial keel. The intercentra display equal width of the inferior surface; and are abruptly rounded at the extremities. The last one preserved is between the second and third caudal centra. It is shorter and wider than the others, and does not display any trace of a chevron bone. The diapophyses are opposite the neural canal on the thirteen anterior vertebræ preserved. Each one sends a horizontal rib forwards to the prezygapophysis, and another obliquely forwards and downwards which stops short of the edge of the centrum. These ribs enclose a fossa in front of the diapophysis. Posteriorly the anteroinferior rib grows more robust, and evidently supports part of the tuberculum of the rib. There is no facet for the capitulum until the antepenultimate vertebra of the anterior series is reached. Here and on the penultimate the anterior border is flattened into a facet, and on the last of the series, the facet marks the summit of a distinct tuberosity, which is produced by the cutting away of the border below it, to accommodate the intercentrum.

The three lumbar vertebræ preserved are different from the dorsals in their greater abbreviation. This character is not unknown in other species of Pelycosauria. The centrum is contracted, but not compressed, at the middle. The diapophysis is altogether on the centrum, and supports no rib-facet. Its anteroinferior buttress is well developed, extending to the

margin of the centrum which is cut out below it for the intercentrum. The sacrum is rather robust. Its two vertebræ are not coössified, and support well developed neural spines, and a large free diapophysis for the ilium. The centra of the caudals, and their diapophyses and neural spines are well developed. There is a fossa at the base of the spine on each side, in line with the zygapophysial surfaces, equidistant between them.

The fragment of ilium is of appropriate size, and is quite robust. It displays the fossa for the sacral diapophysis, and the acetabulum. The latter is remarkable for the prominence of the tuberosity on the superior border, which exceeds that of any species of Pelycosaurian known to me. The section of the ilium through it is triangular.

The dentary bone is accompanied by the splenial to the middle of the symphysis. The latter is not very long. Its dentary portion turns upwards. The ramus is quite robust, differing much from that of the *C. leptocephalus*. It is broken off a little anterior to the tooth line, but the latter probably did not contain more than twenty-two teeth. These have anterior and posterior cutting edges, and are denticulate. The external face of the dentary is excavated by shallow, undulating, branching grooves.

Measurements.			M.
Total length of vertebræ preserved			.640
Diameters centrum of a dorsal vertebra	anteroposterior		.031
	vertical behind diapophysis		.019
	transverse	at end	.021
		at middle	.0115
Diameters neural arch of same vertebra	length with zygapophyses		.041
	width at prezygapophyses		.022
Diameters neural spine of same vertebra	anteroposterior		.0145
	transverse behind		.007
Diameter of intercentrum of do	anteroposterior		.0052
	transverse		.023
Diameters of a lumbar centrum	anteroposterior		.024
	transverse at end		.026
	" " middle		.023
	vertical behind arch		.022
	" at end		.029
Length of sacrum			.055
Diameters of third caudal vertebra	anteroposterior		.024
	vertical at end		.023
	transverse at end		.022
Anteroposterior diameter of acetabulum			.0325
Transverse diameter of ilium at tuberosity			.0265
Length of dentary bone supporting twenty teeth			.044
Thickness at twentieth tooth			.0175
Depth ramus at second tooth			.035
" " " fifteenth tooth			.039

The bones of this specimen are in excellent preservation. They were recovered by Mr. W. F. Cummins from the Peruvian beds of Texas.

EDAPHOSAURUS MICRODUS, sp. nov.

The genus Edaphosaurus Cope, was established on the *E. pogonias* Cope (Proceed. Amer. Philos. Soc., 1882, p. 448), which is represented by a specimen, which includes only a distorted cranium, with most of the parts preserved. The present species is represented by an individual of which I possess numerous vertebræ and ribs, and the dentigerous plates of both jaws. These are part of the dentary splenial in the inferior jaw, and the pterygoid or palatine of the superior. The specimen enables me to determine the characters of part of the vertebral column in the genus Edaphosaurus.

In the first place the vertebræ possess enormously elongate neural spines, as in Dimetrodon. Next, the centra have a facet on the anterior edge above the middle for the head of the rib, as in a mammal. It is not repeated on the posterior edge of any of the thirteen centra preserved. Thirdly, the ribs are only compressed proximally. Distally their section is a wide oval. The extremity is truncate and concave. The shaft is hollow, the walls being thinnest distally.

Specific characters. The grinding teeth of this species are about as numerous as in the *E. pogonias*, there being about seven in a transverse row on each plate. They are, however, less closely placed than in the typical species, and have more conic crowns. They do not form a pavement, as they are separated by wider interspaces.

The centra are rather elongate, and the *foramen chordæ dorsalis* is rather large. No intercentra are preserved, and if present they must have been very small, as the inferior rim of the centrum is not beveled to receive one. The neural spines have transverse processes which commence near the base, and project at intervals from the sides. The inferior ones are oval or subround in section; those which succeed are more or less compressed. The extremities are enlarged fore and aft so as to be claviform in outline, but are compressed except where thickened by lateral tuberosities. These are rarely symmetrical, one being larger and situated higher up, sometimes giving the apex an unsymmetrically bilobate form. Sometimes they project at right angles to the terminal expansion. The shaft of the spine has a rather small medullary cavity, and this issues by an open mouth at the summit of the apex without constriction. This peculiar arrangement suggests a cartilaginous continuation of the spine which retains the nutritive artery of the medullary cavity. The anterior face of the shaft is grooved from the base for some distance upwards; the posterior face is plane and then rounded above.

Measurements.		M.
Diameters of inferior dental patch	anteroposterior	.043
	transverse	.024

Measurements.			M.
Diameters of a posterior dorsal centrum.....	anteroposterior		.0335
	vertical at end.....		.027
	transverse	at end.....	.026
		at middle.....	.015
Measurements of piece of spine of same....	length.....		.132
	diameter at base.	anteroposterior....	.023
		transverse	.019
Diameters of median dorsal.....	vertical ..	at end.....	.032
		behind arch.....	.025
	anteroposterior		.0465
	transverse	at end, at flare.....	.037
		at middle.....	.016
Diameters of summit of spine	anteroposterior.....		.032
	transverse		.032

The ramous character of the neural spines of this species is much like what is seen in the *Dimetrodon cruciger* Cope. The rami in this species, however, retain their size upwards, and become compressed, a feature not seen in the *D. cruciger*. The apices of the spines in the latter species are not dilated as in the *E. microdus*.

Found by W. F. Cummins in the Permian beds of Texas.

THE POSTERIOR FOOT IN PELYCOSAURIA.—The foot-bones of the reptiles of the suborder Pelycosauria are abundant in the collections from the Permian formation, and I have examined my collection for specimens in which they are in normal connection, for the purpose of identifying them. I have been so fortunate as to find an entire tarsus, with the proximal parts of the metatarsi, in the skeleton which served as the type of my description of *Clepsydrops natalis*.* The characters presented by this foot are no doubt present in all of the Clepsydropidæ, which includes the genera Theropleura, Dimetrodon, Embolophorus, and probably others. Tarsal bones identical with those of the *C. natalis* were found with the original specimens of *C. collettii* and others of much larger size, accompany remains of species of Dimetrodon, or Embolophorus.

The astragalus and calcaneum are large and well specialized bones, distinct from each other and from the other tarsal elements. They do not resemble the corresponding bones of any known type of vertebrate, as will presently appear. The navicular bone is distinct, and the cuboid apparently consists of a single element. This depends on the interpretation given to a small bone on its posterior face, which is broken on its free edge, and may be the head of the fifth metatarsus. There are three elements in contact with the distal face of the navicular, which correspond with the three mammalian cuneiforms. The space available for this contact seems hardly sufficient for the three elements present, one of which is out of position and on the inferior side of the carpus. This element

* Proceedings American Philosoph. Society, 1879, 509.

looks also from its free inferior side like an ungual phalange, but is flatter than is characteristic of this family. There are three metatarsals distal to the navicular, which are well accommodated with articular facets on the distal extremities of the three bones in question, so that their identification as the three cuneïforms, is probably necessary. The two remaining metatarsals are articulated, the fourth to the exterodistal facet of the cuboid; and the fifth to the exterior side of the cuboid. The third, fourth and fifth metatarsals are directed at an obtuse angle posteriorly from the long axis of the astragalus.

This structure is more mammalian than any form of foot yet known among reptiles, and agrees with the indications of mammalian character described as existing in the long bones of the limbs by Owen and by myself.

The astragalus is an oblong bone with one long straight side, viz., that which is in contact with the calcaneum. This side has two facets for articulation with the calcaneum, which are separated by a groove, which forms a foramen when the two bones are in place. The proximal extremity of the bone is much smaller than the distal, and is subround. The proximal half of the bone would be nearly cylindric were it not for the truncation caused by the calcaneal facet. The distal half of the bone is robust, and is surrounded on all sides by facets. These are the external or calcaneal, the distal or navicular, and the internal which is larger than the other two together. The first two are oblong and truncate, the navicular twice as large as the calcaneal, its transvere much exceeding its anteroposterior diameter. The internal facet already mentioned, covers the internal face of the distal half of the astragalus, which projects further inwards than the proximal half, rising abruptly from it. The facet is continuous with the navicular, and is at right angles to its plane. It widens proximally, and its proximal border is deeply notched. Its surface is convex from back to front, but not strongly so. In the astragalus of a species of Dimetrodon, it is divided by an angle into two facets, the two faces thus produced being nearly at right angles to each other. This inferior part of the facet is continued into a prominent border which is more or less roughened. A rounded tuberosity of the inferior face of the bone occupies the space between this border and the calcaneal border, so approaching the notch already described, as to cause a groove to proceed from it posteriorly and inwards. I described the corresponding bone in the *Clepsydrops collettii* (Proceeds. Phila. Academy, 1875, p. 409) as a possible coracoid.

The calcaneum has its postero-external edge broken in the specimen of *Clepsydrops natalis* described, but is probably a semidiscoid bone, with its straight margin applied to the astragalus. This margin presents a median flat elongate-oval facet, which is separated by grooves from a facet at each end. The proximal facet is the narrower, and passes by a curve into the proximal extremital facet, which is adjacent to the corresponding proximal facet of the astragalus. The distal internal facet is triangular and wider

than long, and is separated by an angle only from the distal facet. The latter is a little more than a half circle in outline, and joins one bone of the second row, which I suppose to be the cuboid. The fact that it does not articulate with the second element in that row, leads me to suspect that the latter is the head of a fifth metatarsal. The external edge of the bone thins out more rapidly at the distal than at the proximal extremity.

The cuboid bone is pentagonal in outline, and square in transvere section. It is not unlike that of the Amblypodous Mammalia. It has a transverse proximal facet, and two distal ones which meet at an angle about right. The fifth metatarsal is articulated with its posterior face; and the fourth with the exterior distal face. The ectocuneïform articulates with the interior distal face. The navicular bone is subtriangular in transverse section, and with a subquadrate base articulating with the cuboid. Its longitudinal and anteroposterior diameters are about equal. The distal or metatarsal articulation of the entocuneïform is transverse and flat.

The manner of articulation of the ankle-joint must have been different from the usual reptilian type. The proximal extremities of the astragalus and calcaneum combined are not too large to have received the distal extremity of the fibula, so that the tibial articulation must be sought elsewhere. This may have been on the large distal facet of the anterior or inner face of the bone. A part of this facet looks upwards and probably supported the tibia, which was thus removed by a short space from that of the fibula. The down-looking part of the facet, which is more distinct in Embolophorus, must have articulated with a separate element. This may have been a spur, such as exists in the known genera of the Monotremata; as the position is identical with that which bears this appendage in those animals. It is quite evident that an element additional to those known in the ordinary reptilian foot exists in the Clepsydropidæ.

The separation of the distal extremities of the tibia and fibula is not usual among reptiles, but it is common in the salamanders, where the os centrale comes between them. It is also evident that the subcylindric proximal part of the astragalus, which intervenes between the supposed tibial and fibular articulations, represents that bone.

The metatarsals are directed obliquely backwards as well as outwards, as in Tachyglossus and Platypus.

The following results may be derived from the preceding statements: (1) The relations and number of the bones of the posterior foot are those of the Mammalia much more than those of the Reptilia. (2) The relations of the astragalus and calcaneum to each other are as in the Monotreme *Platypus anatinus*. (3) The articulation of the fibula with both calcaneum and astragalus is as in the Monotreme order of mammals. (4) The separate articulation of the anterior part of the astragalus with the tibia is as in the same order. (5) The presence of a facet for an articulation of a spur is as in the same order. (6) The posterior-exterior direction of the digits is as in the known species of Monotremata.

Thus the characters of the posterior foot of the Pelycosauria confirm the

evidences of Monotreme affinity observed by Professor Owen and myself in the bones of the legs, especially of the anterior leg. It remains a fact that with this resemblance in the leg there is a general adherence to the reptilian type in the structure of the skull. But this adherence is not so exclusive as has been supposed, as I will now endeavor to show.

THE STRUCTURE OF THE COLUMELLA AURIS IN CLEPSYDROPS LEPTOCEPHALUS.—As already briefly described above, this element is bifurcate at the proximal extremity. The shorter expanded extremity is the stapes proper. The oblique perforation of its base is a character which has not been hitherto observed in any reptile, not even in the allied form Hatteria (Huxley). If, as is probable, the perforation is homologous with the foramen of the mammalian stapes, we have here another point of resemblance to this class. The longer proximal branch of the columella has only half the width of the stapedial portion, and its long axis makes an obtuse angle with that of the latter. It is perhaps the ossified suprastapedial cartilage of Huxley, which that author states (Anatomy of Vertebrated Animals, p. 77) is not ossified in any of the living Sauropsida. Huxley supposes this cartilage to be the homologue of the incus, and remarks * that in a young Mammalian fœtus "it appears exactly as if the incus were the proximal end of the cartilage of the first visceral arch." The columella now described resembles a rib, of which the suprastapedial process resembles the head, and the stapes the tubercle. If this process be the incus, the stapes is shortened as in the majority of Mammalia, unless the primitive suture between the two be longitudinal. The form and position of the true stapes give support to the view of Salensky, that it is not part of a true visceral arch, but is developed in the connective tissue surrounding the mandibular artery. We see that in this Pelycosaurian it is not the proximal part of the arch, and surrounds the mandibular artery. The columella is divided into at least two distinct elements. This is clearly indicated by its abrupt truncation distally by a rough sutural surface. If there is but one bone distad to the stapes, it is homologous with the cartilage, which has been shown by Peters † to be distinct in Hatteria, crocodiles and various lizards. It is the triangular ligament of Cuvier. If the suprastapedial be incus, this element is malleus; and it is usually identified as such by the older anatomists. In this structure we have evidence that the hypothesis that the articular and quadrate bones are homologous with the ossicula auditus is incorrect. The Pelycosauria will probably come under the head of "Sauropsides malleoferes" of Albrecht. We have here an approximation to the Mammalia in two points: (1) The perforation of the head of the stapes; (2) and the ossification of the incus, which (3) is distinct from the malleus, thus furnishing homologues of the principal ossicles of the ear. It

* Proceedings Zool. Society, London, 1869, p. 391.
† Monatsberichte der Academie Sciences, Berlin 1868 (p. 592)—1870.

is unnecessary to observe however, that this part of the skeleton does not resemble the corresponding part in the known Monotremes.

Structure of the quadrate bone in the genus Clepsydrops.—The quadrate bone in *Clepsydrops leptocephalus* Cope, already described, is of highly interesting form. It consists of two portions, a vertical and a transverse, the latter much longer than the former. The vertical portion is wedge-shaped with the base fashioned into the condyle for the mandibular ramus. Its posterior face to the apex, is articulated with the large squamosal, which rises towards the parietal bone. The distal part of the quadrate is grooved anteriorly, and each edge sends a process forwards. The internal is short, and articulates with the pterygoid. The external is the long horizontal part of the bone already mentioned. It is compressed, and at the end is acuminate. Although the malar bone is out of place in the specimen described, examination of the skull of the *Clepsydrops natalis*, where it is preserved in position, shows that this horizontal ramus of the quadrate is nothing more than the zygomatic process of the squamosal bone of the Mammalia, forming with the malar bone the zygomatic arch. *In the Pelycosauria there is but one posterior lateral arch*, as is demonstrated by many specimens; hence, we have here a reptile with a zygomatic arch attached to the distal extremity of the quadrate bone.

Important results follow this determination. We have seen that, with Peters, we need no longer look to the auricular chain of ossicles, and especially to the incus, to find the homologue of the os quadratum of the Vertebrata below the Mammalia. According to Albrecht *the os quadratum is the homologue of the zygomatic portion of the squamosal bone.* If this be true, in the process of specialization of the reptiles, the anterior or zygomatic portion of the quadrate has been lost or separated as a quadratojugal bone, and the condylar portion extended, until it has reached the extreme length we observe in snakes. This determination of the character of the quadrate bone in the Theromorphous Reptilia is confirmatory of the theory broached by Albrecht.* Among many propositions novel to the science of osteology, none has been more unexpected than his assertion that the quadrate bone is the homologue of the zygomatic and glenoid portion of the squamosal bone of Mammalia. This is in contradiction to the view held by many comparative anatomists from the day of Reichert to the present time.

I made a study of these arches several years ago, which is published in the Proceedings of the American Association Adv. Science, Vol. xix, p. 18. Accepting the prevailing view that the quadrate bone is one of the auditory ossicles, I naturally homologized the superior arch of the reptilian skull, which articulates with the squamosal proper, with the zygomatic arch, and looked upon the quadratojugal arch as an additional structure, connected with the peculiar development of the supposed incus.

* Sur la valeur morphologique de l'articulation mandibulaire et des osselets de l'oreille, etc., Bruxelles, Mayolez, 1883.

Should Albrecht's determination of the homology of the quadrate bone prove to be correct, the quadratojugal arch is the zygomatic, and the superior arch becomes the accessory one. This being admitted, the Lacertilia cannot be said to have a zygomatic arch, and the Theromorpha do not possess their postorbito-squamosal arch; the diversity between the two orders being thus greater than has been supposed.

THE ARTICULATION OF THE RIBS IN EMBOLOPHORUS.—The ribs of the Theromorpha are two-headed. While the tubercular articulation has the usual position at the extremity of the diapophysis, the capitular is not distinctly, or is but partially indicated, on the anterior edge of the centrum, in Clepsydrops and Dimetrodon. In Embolophorus, as I showed in 1869, the capitular articulation is distinctly to the intercentrum. A second and larger species of that genus, recently come to hand, displays this character in a striking degree, since the intercentrum possesses on each side a short process with a concave articular facet for the head of the ribs. From the slight corresponding contact with the intercentrum seen in Dimetrodon and other genera, there can be little doubt that this is the true homology of the ribs in the order Theromorpha.

The consequence follows from this determination, that the ribs of this order are intercentral and not central elements, and that they do not therefore belong to the true vertebræ, thus agreeing with the chevron bones, with which they are homologous.

It is also true that this type of rib-articulation *approximates closely that of the Mammalia*, where the capitular articulation is in a fossa excavated from two adjacent vertebræ. This is what would result if the intercentrum were removed from a Theromorph reptile, and the head of the rib allowed to rest in the fissure between the centra left by the removal. It is well known that the double rib articulation of the other reptilian orders which possess it, viz.: Ichthyopterygia, Crocodilia, Dinosauria and Pterosauria, and in the birds, is different, the capitular connection being below the tubercular, on the centrum. Whether the capitular articulations and the ribs in these orders are homologous with those of the Theromorpha, remains to be ascertained,

THE ORIGIN OF THE MAMMALIA.—The relation of the characters of the Pelycosaurian suborder of the Theromorpha to those of the Mammalia may now be seen to be very important. I give a synopsis of the characters of these divisions parallel with those of the Batrachia contemporary with them, in order to give a clear idea of the reasons for believing that *the Mammalia are the descendants of the Pelycosauria.*

The following table shows that the Mammalia agree with the Batrachia n two and part of another character; with the Pelycosauria in six characters, and with other Reptilia in two characters. The Pelycosauria agree with the Batrachia in two and in parts of two other characters, and with other Reptilia in three characters, two of which (Nos. 2 and 3) are of prime importance. Of the characters in which the Pelycosauria agree

	Batrachia.	Pelycosauria.	Other Reptilia.	Mammalia.
1. Basicranial axis,	Unossified and with a parasphenoid.	Ossified; no parasphenoid.	Ossified; no parasphenoid.	Ossified; no parasphenoid.
2. Occipital condyle,	Two.	One.	One.	Two.
3. Quadrate bone,	Separate.	Separate.	Separate.	"Coössified with squamosal."—(Albrecht.)
4. Postorbitosquamosal arch,	Present (in Permian forms).	Wanting.	Present (generally).	Wanting.
5. Coracoid bone,	Small, coössified.	Small, coössified.	Large, distinct.	Small, coössified.
6. Ribs,	Diapophysial.	Intercentral.	Diapophysial and central (in position).	Intercentral.
7. Pelvis,	Without obturator foramen.	Without obturator foramen.	With obturator foramen.	With obturator foramen.
8. Posterior foot,	Intermedium, tibiale, fibulare and centrale distinct.	Tibiale, fibulare and centrale distinct; intermedium united with tibiale.	Intermedium, and centrale not distinct; tibiale and fibulare generally not distinct.	Tibiale, fibulare and centrale distinct; intermedium united with tibiale.
9. Humerus,	With condyles.	With condyles and epicondylar foramen.	No epicondylar foramen rarely condyles.;	Condyles; frequently epicondylar foramen.

with the Mammalia, two are of first class importance (Nos. 1 and 5); three are of great but unascertained degree of importance (Nos. 4, 6 and 8), and one (No. 9) is of less importance. The two characters (Nos. 2 and 5) in which the Mammalia agree with the Batrachia, are of high importance, but one of them is also a point in which the Pelycosauria agree with both (structure of the coracoid bone, No. 5). There is but one character, the distinctness of the quadrate bone, in which the Batrachia agree with the Reptilia in general.

The preceding comparison renders it extremely probable that the Mammalia are descended from the Pelycosaurian Reptilia. The usual definitions have been invalidated, excepting that of the occipital condyles, but even this is not so absolute a character as has been supposed. In the gecko lizard, Uroplates, the occipital condyle is represented by the exoccipital pieces only, the basioccipital element being omitted nearly as in the Mammalia. Professors Huxley and Parker have declared it as most probable that the true ancestor of the Mammalia have been the Batrachia. It is evident that the Pelycosauria are in various respects the most Batrachian of the Reptilia, for they agree with them in three and parts of two other characters of the nine above enumerated. One of the latter is the structure of the posterior foot, which displays much less modification from the Batrachian type than that of the ordinary Reptilia.

The first evidence of the resemblance of the Pelycosauria to the Mammalia was empirical and not conclusive. This consisted in the characters derived from the long bones of the limbs. Professor Owen first called attention to this resemblance in the genus Cynodraco, which is a Theromorph reptile. I next pointed out corresponding peculiarities in the humeri of the American Theromorphs. I subsequently showed the resemblance between the pelvis of the Pelycosaur division, and that of the Monotremata. This was followed by a demonstration of the resemblance between the coracoid of the Pelycosauria and the Mammalia of the Monotrematous order, especially the family of the Platypodidæ. The present article now adds that the structure of the posterior foot approaches near to that of the Monotremata; and that the os quadratum and the ribs are essentially like the corresponding parts in all the Mammalia. The last three points are essential and fundamental. The three great distinctions between the Mammalia and Reptilia in the skeleton are: (1) in the quadrate bone; (2) in the coracoid bone, and (3) in the occipital condyle. Of these the last only now remains, and this is weakened by the presence of the Mammalian type in the geckotian lizard already referred to. The only interruption in the series which has not yet been overcome is in the columella auris. No reptile is yet known where that element is divided into incus, orbicularis, and stapes, as in the Mammalia and some Batrachia (according to Albrecht). Of course the above comparison with the Monotremata considers the latter order in its proper ordinal definitions, and not in its special subordinate modifications now existing, the Platytidæ and Tachyglossidæ. Monotremata dentition like that of the known Jurassic and Triassic Mammalia will doubtless yet be discovered in beds of those ages.

As this paper goes to press, the interesting announcement made at the meeting of the British Association for the advancement of science at Montreal may be referred to. Mr. Caldwell, the holder of the Balfour scholarship, telegraphs that he has discovered that the *Platypus anatinus* is oviparous, and that the egg is meroblastic. This confirms the hypothesis of descent from reptilian ancestors rather than Batrachian. Haeckel gives the segmentation as meroblastic, Studien zur Gastræa Theorie, Jena, 1877, p. 65.

NOTE ON THE TARSUS.—I am just in receipt of an MS. from Dr. Baur, of New Haven, in which he presents an identification of the "internal navicular" bone of some rodents, and which probably existed in the ungulate genera Pantolambda and Bathmodon. He identifies it with the tibiale, and denies that the astragalus includes that element, but that it consists wholly of the intermedium. This identification will also apply, though Dr. Baur in his manuscript does not make it, to the element which supports the spur in the known Monotremata. It will also explain the nature of the element which occupies the same position in the foot of the Pelycosauria above described. The arrangement in this order of reptiles confirms the conclusion reached by Dr. Baur, since the questionable element is here in direct contact with the tibial facet of the astragalus.

NOTE ON PHYLOGENY OF THE VERTEBRATA.—As my researches have now, as I believe, disclosed the ancestry of the Mammals,* the birds,† the reptiles, and the true fishes,‡ or Hyopomata, I give the following phylogentic diagram illustrating the same. This will only include the leading divisions. The special phylogenies of the Batrachia‖ and Reptilia,§ and some of the Mammalia¶ have been already given.

The Mammalia have been traced to the Theromorphous reptiles through the Monotremata. The birds, some of them at least, appear to have been derived from the Dinosaurian reptiles. The Reptilia in their primary representative order, the Theromorpha, have been probably derived from the Rhachitomous Batrachia. The Batrachia have originated from the subclass of fishes, the Dipnoi,‡ though not from any known form. I have shown that the true fishes or Hyopomata have descended from an order of sharks,‡ the Ichthyotomi, which possess characters of the Dipnoi also. The origin of the sharks remains entirely obscure, as does also that of the Marsipobranchi. Dohrn** believes the latter class to have acquired its

* American Naturalist, 1884, p. 1136.

† Proceedings Academy Philadelphia, 1867, 234.

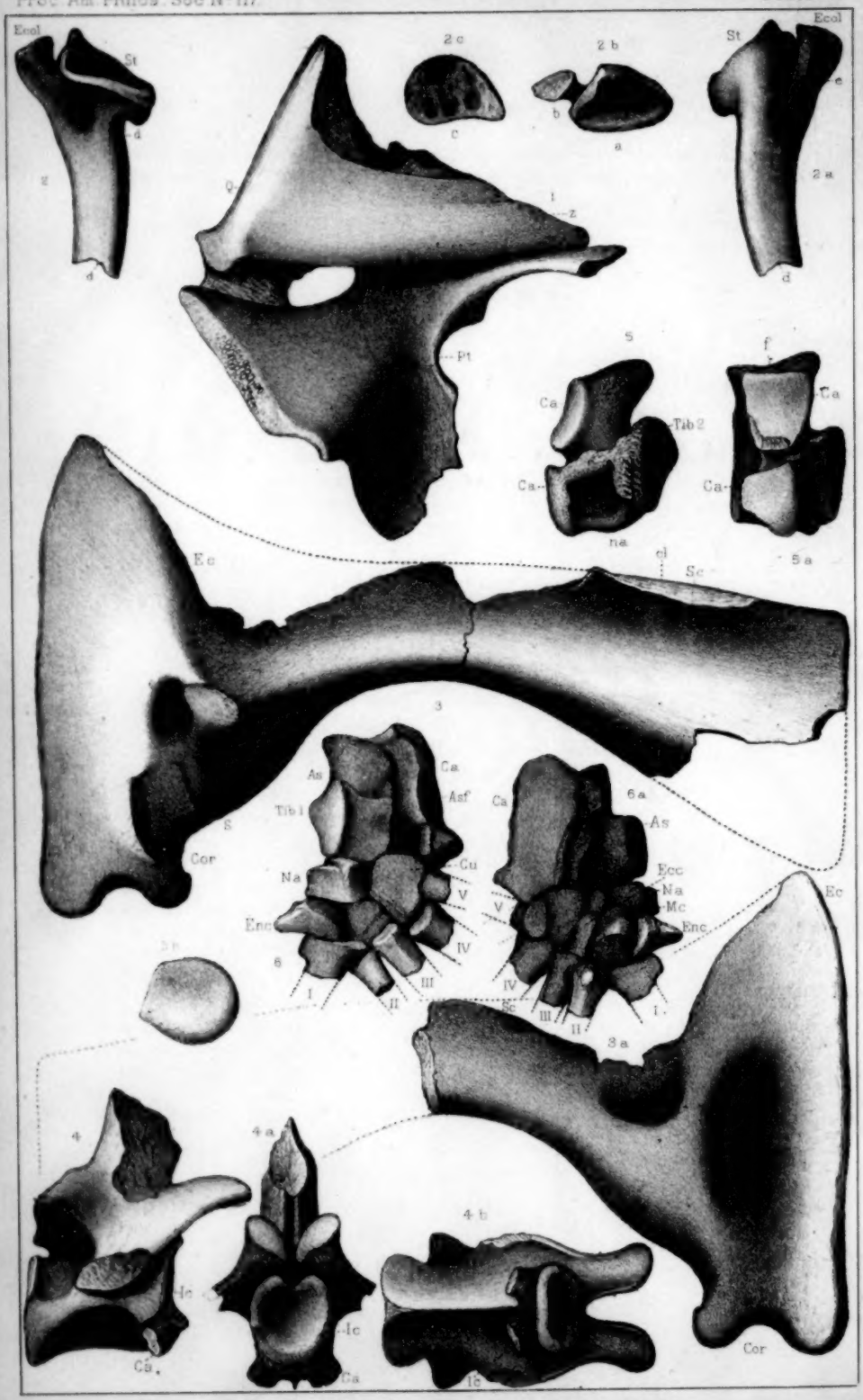
‡ Proceedings American Philosophical Society, 1884, p. 585.

‖ American Naturalist, 1884, p. 27.

§ Proceedings American Association for the Advancement of Science, xix, 1871, 233.

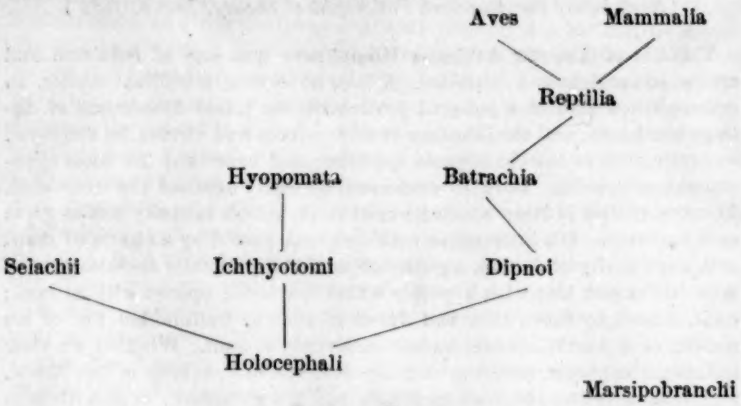
¶ Proceedings American Philosophical Society, 1882, 447; American Naturalist, 1884, p. 261 and 1121. Report U. S. Geol. Survey W. of 100th Mer., G. M. Wheeler 1877, iv, ii, p. 282.

** Der Ursprung der Wirbelthiere u. d. Princip des Functionwechsels, von Anton Dohrn, Leipsic, 1875, p. 32.



BONES OF PELYCOSAURIA.

present character by a process of degeneration. The origin of the Vertebrata is as yet entirely unknown, Kowalevsky deriving them from the Tunicata, and Semps from the Annelida.



EXPLANATION OF PLATE.

Fig. 1. *Clepsydrops leptocephalus* Cope, right quadrate bone (Q) with condyle and zygomatic process (*z*) from the right, or external side *Pt*, pterygoid bone of same side displaced so as to be in plane of quadrate, and to be seen from inferior side. One-half natural size.

Fig. 2. Columella auris of the individual of *Clepsydrops leptocephalus* represented in fig. 1; internal side. Fig. 2*a* external side; 2*b* proximal extremity; 2*c* distal extremity; *s*, head of stapes; Ecol. epicolumella; *d*, distal articular surface, especially represented in fig. 2*c*. All figures are half natural size, excepting 2*c*, which is natural size.

Fig. 3. Left half scapular arch of a Pelycosaurian, less clavicle and episternum, one-half natural size. *sc*, scapula; *cl*, facet for clavicle; *cor.* coracoid; *ec*, epicoracoid; *s*, open suture between coracoid and epicoracoid, indicating the immaturity of the animal.

Fig. 4. Dorsal vertebra of a species of Embolophorus, one-half natural size; right side; *a*, from front; *b*, from below; *ic*, intercentrum; *ca*, capitular rib articulation.

Fig. 5. Astragalus of individual figured in fig. 4, one-half natural size; from below. *ca*, *ca*, facets for calcaneum; *na*, do. for navicular; *tib*, 2, do. for bone of spur, or os tibiale. 5*a*, same bone from external or calcaneal border; *f*, fibular facet. 5*b*, same bone, proximal or fibular extremity.

Fig. 6. Left posterior foot of *Clepsydrops natalis* Cope, superior side, and 6*a*, inferior (plantar) side, two-thirds natural size. *as*, astragalus; *ca*, calcaneum; *na*, navicular bone; *cu*, cuboid; *euc*, *mc* and *ecc*, entocuneïform, mesocuneïform and ectocuneïform bones, respectively. I, II, III, IV, V, metatarsals. *Tib* 1, Probable tibial facet. In this specimen the calcaneum is displaced; being turned backwards, so as to present its two astragalar facets (*as'*) anteriorly.

Andrew Atkinson Humphreys, Brigadier-General U. S. Army, Brevet Major-General U. S. Army, Chief of Engineers. By Hampton L. Carson.

(Read before the American Philosophical Society, Dec. 5, 1884.)

The life of Andrew Atkinson Humphreys was one of reflection and action, of incident and character. A man of science, a brilliant soldier, an accomplished scholar, a polished gentleman, the lineal descendant of distinguished men, and the inheritor of their talents and virtues, he displayed in every walk of life the highest qualities, and combined the most opposite characteristics. Born to command, he easily attained the front rank in every species of labor which he undertook, yet his modesty was as great as it was rare. His intercourse with men was graced by a charm of manner, a simplicity of diction, a purity of sentiment, a gentle resistlessness of will that armed him with a power which few could oppose with success; or if, misled by these, they had dared to stir the half-hidden fire of his nature, they would have found him as terrible as Saul. Whether we view him as an engineer, investigating the destructive dynamics of our floods, and demonstrating the laws by which they are governed; or as a division commander leading his troops to the fierce assault, and animating them by his personal example; or as the chief of staff of the commander of a great army, sagacious, practical and fertile in resources; or as a corps commander, skillful and intrepid; or as the chief of engineers, broad-minded and profound; or as a military writer, luminous yet terse, we find his career marked with capacity, energy, and success. As Sallust said of Jugurtha, he was, indeed, both brave in action and wise in council; qualities very seldom united in the same person, precaution being generally accompanied with timidity, and courage with rashness. The most conspicuous of his virtues were truth, integrity and honor. A devoted husband, a tender father, an affectionate brother, a generous and unflinching friend, with a chivalrous regard for woman worthy of the best days of heraldry, he was in public and in private, a man to be feared, to be trusted, to be admired, to be loved; a man with whom no one could trifle, and whom no one would care to offend.

The name of Humphreys is of Norman origin, and can be traced for a thousand years. It occurs in Doomsday book as Humfridus—subsequently spelled as Humfrey or Humphry—and six coats-of-arms, all very ancient, appear to have been brought into the Herald's office in 1340, upon its first establishment.* The crest of one branch of the family—a lion with his dexter paw upon a nag's head—refers most probably to the conquest of Wales, where the sturdy victors dwelt upon the lands of which they gat possession through their swords. Here they remained for seven hundred

*See Marshaling and coat-of-arms presented to Gen. David Humphreys, LL.D., by Ozias Humphreys, artist, of London, about 1790; preserved among his papers and presented by the widow of William Humphreys, nephew of Gen. David Humphreys, to Dr. Frederick Humphreys in 1863. Illuminated copy of the coats-of-arms of the Humphreys family in possession of the writer.

years, when one of their number, Daniel Humphreys, of Porthwen, Merionethshire, Wales, came to Pennsylvania in 1682, and settled in Haverford township, now of Delaware county, about seven miles west of Philadelphia, and was followed the next year by his mother Elizabeth, the widow of Samuel Humphreys, with her younger children.* He had joined the Friends in his native country, "and left such a testimony behind him as is and was of good savor."† In 1695 he was married to Hannah, the daughter of Dr. Thomas Wynn, of Merion. They had many children, among whom were Joshua, Edward and Charles. Joshua was the great-grandfather of the subject of this sketch. Edward acquired a high reputation as a physician and surgeon, and was beloved for his benevolence and humanity. Charles Humphreys was a man of fine talents, and of great influence in the county. In 1764, he was elected to the Provincial Assembly, and was reëlected annually to that office, until 1775, when he was chosen a member of the Continental Congress. In that body he contended with energy against the oppressive measures of Great Britain, but, fettered by his oath of allegiance, and by what he believed to be the views of a large majority of his constituents, he voted with John Dickerson, Thomas Willing, Edward Biddle, and Andrew Allen, against the Declaration of Independence. He then retired to private life, and though sympathizing with his country, took no part in the struggle.‡

Joshua Humphreys, the son of Joshua, and grandson of Daniel Humphreys, the immigrant, was the grandfather of Andrew Atkinson Humphreys. He was born in Haverford township in the year 1751. His mother was Sarah, the daughter of Edward and Elinor Williams, of Blockley. His ancestors were thoroughly Welsh, and all of them Quakers. With only the advantages of such an early education as the common schools of the country afforded at that day, Joshua was apprenticed at a tender age to a ship carpenter of Philadelphia. Before the completion of his apprenticeship his instructor died, and he was at once placed at the head of the establishment, and managed the business for the widow for several years with prudence and success. Possessing a comprehensive and philosophical mind, he soon came to be regarded as the first naval architect in the country. Such was his eminence, that after the adoption of the Constitution of the United States, and when it became apparent that our Government must have a navy, Mr. Humphreys was consulted, offi-

* Elizabeth Humphreys and her children were all Friends. She brought a certificate with her that recommends her "for an honest, faithful woman yt has been serviceable in her place, and praiseworthy in her conversation," and her children "as tender plants growing in that which they do profess, even the truth and Grace of God." Copy of original certificate in possession of the widow of Gen. A. A. Humphreys, Smith's History of Delaware County, Pennsylvania, p. 471.

† Biographies of early settlers and eminent men of Delaware county. History of Delaware County, Pennsylvania, by George Smith, M.D., p. 471.

‡ Centennial collection. Charles Humphreys. The Pennsylvania Magazine of History and Biography, Vol. i, p. 83. Smith's History of Delaware County, p. 472.

cially, and his views, which had been communicated to the Hon. Robert Morris, in a letter dated January 6th, 1793, but more in detail to Gen. Knox, then Secretary of War, were, in the main, adopted. He was the first naval constructor of the United States, and several of our first ships of war, the *Constitution*, the *Chesapeake*, the *Congress*, the *Constellation* and the *President* were built according to his plans, and the *United States* was built at his own yard under his immediate direction.* These were the famous ships whose marvelous success may be gathered from the annals of the naval warfare with Tripoli in 1804 and with Great Britain in 1812.†

Very justly Mr. Humphreys has been called the Father of the American Navy. The last thirty years of his life were spent in quiet retirement on a part of his patrimonial estate, Ponte-Reading, in Haverford. Here he died in 1838, at the advanced age of eighty-seven years, with mental faculties unimpaired.

Samuel Humphreys, a son of Joshua, was educated by his father as a naval constructor, and some of the most beautiful ships in our navy were from his models.‡

In 1813 he was appointed naval constructor for the Philadelphia Navy Yard, and, in 1826, by President John Quincy Adams, Chief Naval Constructor of the United States, a position which he held until his death in 1846. One incident in his career deserves to be narrated. When Izakoff, a special ambassador, who had been sent to America by the Emperor Alexander, with authority to engage the best shipbuilding talent for the construction of a Russian navy, sought to fulfill the imperial instructions, he sent, through Mr. Richard Peters, for "Sam. Humphreys." He offered him a salary of $60,000 per annum, a town house and a country residence

* The Lives of Eminent Philadelphians, now deceased, p. 588.
Naval History of the United States, by J. Fenimore Cooper, Vol. 1, p. 149.
American State Papers. Vol. 1, p. 402.
The Commencement of the United States Navy, 1794, by Rear Admiral George H. Preble, The United Service, February, 1884, pp. 139-149.

† The main idea of Mr. Humphreys was that the ships should be heavier in tonnage and artillery than their rates would seem to authorize; they proved fast sailers, capable of enduring heavy battering, and of inflicting severe injuries in a short space of time. So terrible was their armament that the British termed them "74's in disguise."

‡ Clement Humphreys, the eldest son of Joshua, gave evidence, when a mere lad, of spirit and daring. Infuriated over an attack in the columns of the *Aurora* upon the Federalists and upon the late President Washington, on the 4th of April, 1797, he violently assaulted the editor, who was visiting the frigate, the *United States*, then on the stocks at Philadelphia. He was tried for assault and battery and convicted, and was fined $50, and ordered to give security in the sum of two thousand dollars to keep the peace. Such was the admiration of his conduct on the part of the Federalist merchants of the city that they paid the fine and furnished the security. President Adams subsequently sent him to France with special despatches—a reward, as hostile critics asserted, for having thrashed a Republican.
The Aurora, General Advertizer, Philadelphia, April 6, 1797. History of Philadelphia, by Thompson Westcott, Chap. ccexxxiii. Hildreth's History of the United States, second series, Vol. ii, p. 44.

to be maintained by the Czar, horses and coaches, and servants, and if these were insufficient, he could name his own terms. After a day's consideration, Humphreys replied: "The salary is greater than I could earn; more than I need; more than I want; more than I could use. As to the town house and country-house, I need but one, and that should be near my business. As to the coaches and servants, I always walk and wait upon myself, and should find myself unable to govern a multitude of servants. I do not know that I possess the talents my friend, Mr. Peters, ascribes to me; but I do know and feel that, whether my merit be great or small, I owe it all to the flag of my country, and that is a debt I must pay." *

In the history of refusals of dazzling offers, where can the parallel of this instance of lofty patriotism be found?

Such a man was the father of Andrew Atkinson Humphreys.

The maternal grandfather of General Humphreys, and for whom he was named, was Andrew Atkinson, of Prehend Caven-Garden, Ireland, and his maternal grandmother was Jane Murray, the daughter of Sir Archibald Murray, the descendant of that Murray of Black Barony, in Scotland, who espoused the cause of the Pretender. The story runs that Andrew Atkinson, then a gallant ensign in the British army, of nineteen years of age, first saw Jane Murray, a beautiful girl of sixteen, on the battlements of Edinburgh Castle, and, captivated by her charms, gracefully lowered his colors as he passed. He sought and obtained an introduction, which resulted in their elopement and marriage. He subsequently purchased a plantation in Florida, upon the St. John's river, and after the cession of Florida by Spain, came to Philadelphia, where he died. His daughter, Letitia Atkinson, met Samuel Humphreys at Dungeness, the house of the widow of General Nathaniel Greene, upon Cumberland Island, Georgia, whither he had been sent, as a youth of eighteen, to inspect live-oak timber for the great battle ships, and the meeting led to their marriage. They had eight children, of whom Andrew Atkinson Humphreys was the second son.

I have dwelt at length upon the ancestry of General Humphreys, because in the analysis of his character it is interesting to trace to their source his many admirable traits.† The blood of Normandy, Scotland, Ireland and Wales was commingled in his veins, an apt admixture for the production of thorough manliness. From his father's side he inherited his dauntless spirit, his inflexible resolution, his spotless integrity, his patriotism and great philosophical powers of mind. From his mother, who was a woman of loveliness and grace, his exquisite charm of manner, his strict self-control, his unwillingness to believe evil report of any one, his

* Samuel Humphreys, Chief Naval Constructor of the United States, The Pennsylvania Magazine of History and Biography, Vol. viii, p. 216.

† Mr. Galton, in his work on Hereditary Genius, marshals an imposing array of evidence in support of his proposition, that genius, talent or whatever we term great mental capacity, follows the law of organic transmission—runs in families, and is an affair of blood and breed.

readiness to admit of every palliation of bad conduct, without any weakness or credulity of judgment, and his exalted admiration of woman. His nature responded to his mother's gentlest touch, and she always spoke of him as "my sympathizing child."

Andrew Atkinson Humphreys was born in the city of Philadelphia, November 2, 1810. As a boy, he was fearless, upright and honorable, with a determined spirit of resistance to anything like tyranny or personal affront; first in all manly sports and a leader in daring exploits. His early education was received at "Tommy Watson's," the Germantown Academy, and the school of an Englishman named Warren, who unfortunately used the rod. To the indignity of personal chastisement young Humphreys was too spirited to submit, and no command, entreaty or persuasion could induce him to return to the school, though the teacher himself called upon his parents, regretting the loss of a pupil of talents and ability, and promising an entire change of treatment. He then went to the Moravian school for boys at Nazareth, Pennsylvania. In after life he frequently alluded with emotion to the happy days spent at the latter institution, where he said he imbibed a taste for reading and music. Subsequently, he had a private tutor, and in his seventeenth year went to West Point, July 1, 1827; was graduated thirteenth in a class of thirty-three, July 1, 1831, and was assigned to the Second Artillery, with the rank of Brevet Second Lieutenant. Among his classmates were Roswell Park, Henry Clay, a son of the distinguished statesman, George Turner, Samuel C. Ridgeley, George H. Talcot, William H. Emory, William Chapman, Thomas McKean, Henry Van Rensselaer, Edward Ogden, Samuel G. Curtis, and James Williams.*

He served in garrison at Fort Moultrie, S. C., in 1831; was assigned to temporary duty at the United States Military Academy in 1832; to the Cherokee Nation in 1832 and 1833; and to Augusta Arsenal, Ga., and Fort Marion, Fla., 1833 and 1834. He was on Topographical duty, making surveys in West Florida and at Cape Cod, Mass., in 1834 and 1835, and participated in the Florida war against the Seminole Indians in 1836, being engaged in the action of Oloklikaha, March 31, 1836, and the action near Micanopy, June 9, 1836.

On September 30, 1836, he resigned his commission as an officer of the United States Army, and during the years 1836–'38, as Civil Engineer, assisted the late General Hartman Bache on the plans of Brandywine Shoal Lighthouse and Crow Shoal Breakwater, Delaware bay.

Upon the re-organization of the Corps of Topographical Engineers in 1838, General Humphreys was re appointed in the Army, with the rank of First Lieutenant in that Corps.

He served in charge of works for the improvement of Chicago harbor, Ill.; as Assistant Topographical Engineer of survey of Oswego harbor defences, N. Y., and in charge of survey of Whitehall harbor, N. Y., in

* Class of 1831, Cullum's Biographical Register of the Graduates of West Point.

1839; as Assistant in the Topographical Bureau at Washington, D. C., 1840–'41; in the Florida war, 1842; on construction of bridge at Washington, D. C., 1842; as Assistant in Topographical Bureau at Washington, D. C., 1842–'43–'44; as Assistant in charge of the Coast Survey Office at Washington, D. C., 1844–'49, and on surveys in the field, 1849–'50.

He was engaged in making a Topographic and Hydrographic survey of the Delta of the Mississippi river, with a view to its protection from inundation, and deepening the channels at its mouth, 1850–'51, continuing in general charge of the work and preparing his able and voluminous report thereon, till 1861. In 1853 he was sent on special duty to Europe to examine means for the protection of delta rivers from inundation. He was in general charge, under the War Department, of the office duties at Washington, D. C., connected with the explorations and surveys for railroads from the Mississippi river to the Pacific ocean, and geographical explorations west of the Mississippi river, from 1854 to 1861, and was a member of the Lighthouse Board, from 1856 to 1862; of the Board "to revise programme of instruction at the United States Military Academy," and of the Commission created by act of Congress "to examine into the organization, system of discipline, and course of instruction at the United States Military Academy, 1860."*

It would be difficult to overestimate the value and extent of the labors of General Humphreys in the field of science. I can dwell only upon his greatest work: *The Report upon the Physics and Hydraulics of the Mississippi River; upon the Protection of the Alluvial Region against Overflow; and upon the Deepening of the Mouths; Based upon Surveys and Investigations, made under the Acts of Congress directing the Topographical and Hydrographical Survey of the Delta of the Mississippi River, with such Investigations as might lead to determine the most Practicable Plan for Securing it from Inundation, and the best mode of Deepening the Channels at the Mouths of the River.*†

The title but feebly suggests the vast scope of the work.

The Mississippi river, below the mouth of the Missouri, changes its character from a gentle current and a clear tide to a turbid, boiling torrent, tremendous in volume and force. Thenceforth, for thirteen hundred miles, it pursues a devious course, washing away banks and islands here, rebuilding them there, absorbing tributary after tributary, until at last it is itself swallowed up in the greater volume of the Gulf. Just above the mouth of the Ohio begins a great alluvial plain, some fifty miles in

* Statement of Services of Brigadier-General Andrew A. Humphreys, Corps of Engineers, Brevet Major-General U. S. A. General Orders, No. 10, Headquarters Corps of Engineers, U. S. A., Washington, D. C., December 29, 1883.

† Submitted to the Bureau of Topographical Engineers, War Department, 1861. Prepared by Captain A. A. Humphreys and Lieutenant H. L. Abbot, Corps of Topographical Engineers, United States Army. Philadelphia: J. B. Lippincott & Co. 1861. 4to, pp. 456; with an Appendix, pp. 146, and 20 plates. Reprinted, with Additions, in 1876.

width, which is mostly below the level of the floods. In extent the valley of the Mississippi is equal in surface to all Europe, except Russia, Norway and Sweden. It has no topographical obstructions. It contains immense navigable rivers, and is connected with vast inland seas. A great historian, with the inspiration of a prophet and the fire of a poet, has predicted that "with such a varied and splendid entourage—an imperial cordon of States—nothing can prevent the Mississippi valley from becoming in less than three generations the centre of human power."* The problem of protection against overflow is the great practical question involving the prosperity of that entire region. Millions of dollars had been fruitlessly expended by the States of Louisiana, Arkansas and Missouri, through want of concert, want of knowledge and misdirected and divided effort. Politics, too, embroiled the results, so that when, in September, 1850, the Federal Government granted to the several States bordering on the river all the swamp and overflowed lands within their limits, remaining unsold, in order to provide a fund to reclaim the districts liable to inundation, the planters in the lower valley of the river, alarmed lest the effect of the reclamation of vast swamps above should tend to increase the floods below, invoked the aid of the General Government in the necessary surveys for investigating the matter. From this movement the Delta Survey took its origin.†

From the beginning the work was in charge of Captain Humphreys. He began field operations in November, 1850, but was compelled by severe illness, occasioned by exposure and overwork in surveying, to suspend them in the summer of 1851. He long remained an invalid, and upon his recovery was overwhelmed with other professional duties—among which may be named the general charge of all the Pacific Railroad surveys—so that the river work was not resumed until 1857. From that time, at his own request, he had the assistance of Lieutenant H. L. Abbot, to whom, with rare and characteristic liberality, he attributed an equal share in the authorship of the work. In his letter to the Bureau, Captain Humphreys, in speaking of the work, says: "It involved an amount of labor and study which will not, perhaps, be fully appreciated even by professional persons."

A scheme of field observations was devised covering a multitude and variety of observations in a vast region of more than one and a quarter millions of square miles, including the basins of the eight principal tributaries of the river, draining the entire surface between the Rocky mountains and the Alleghenies—the Missouri, Ohio, Upper Mississippi, Arkansas, Red, White, Yazoo, and St. Francis. The work was distributed among topographical, hydrographical and hydrometrical parties. An

* History of the American Civil War, by John William Draper, M.D., LL.D. Vol. i, pp. 62.

† In the preparation of this account I have been assisted in my study of the original work by an able and exhaustive review of the Report of Humphreys and Abbot, by Edwin Hale Abbot, A.M., reprinted from the North American Review, April, 1862.

enormous mass of facts and data was collected and tabulated, showing the length, slope, dimensions of cross-sections, discharge, area of basin, downfall of rain, and drainage of the Mississippi and its tributaries. In this way all of the important facts connected with the various physical conditions of the river were ascertained, reduced and digested; the laws uniting them were determined, and out of seeming chaos the beautiful results of science were evolved, leading to simple and practical conclusions, and the great problem of protection against inundation was solved. Various suggestions, theories, and expedients, which had been much discussed in Europe, and broached in this country by Charles Ellet, were disproved and condemned. In the language of the Report: "It has been *demonstrated* that no advantage can be derived either from diverting tributaries or constructing reservoirs, and that the plans of cut-offs and of new or enlarged outlets to the Gulf, are too costly and too dangerous to be attempted."

The decision was in favor of the system of levees.

The question of the protection of the valley from inundation having been satisfactorily determined, attention was next directed to the improvement of navigation by the deepening of the mouths of the river. The first problem was one of national, the second of international, importance. In the same thorough way the facts relating to the delta were collected and studied, as well as those relating to the mouths of the river and their bars, and a plan was reported for increasing the depth of water on the bars. A ship canal was urged to obviate the difficulties and dangers of the passes, while the temporary and fallacious expedient of jetties was strongly condemned.

The spirit in which the entire work was executed is that of the well-chosen motto of the title page—the words of Franklin to Abbé Souliave—"I approve much more your method of philosophizing, which proceeds upon actual observations, makes a collection of facts, and concludes no further than those facts will warrant."

In addition to the purely scientific features of the work, it contains chapters of the utmost historic value. In chapter iii, the state of the science of hydraulics, as applied to rivers, is exhaustively considered. A complete chronological list is given of all the works bearing upon it, with a résumé of their contents. It sets forth all that was previously known about river hydraulics, both in Europe and in this country; with special studies, in part conducted by General Humphreys when in Europe, of the Nile, Neva, Rhine, Rhone, Garonne and the Po. The phenomena of great floods from 1718 to 1859 are fully stated, and a succinct account is given of the progress of the levee system in the Mississippi valley.

Finally, in elaborate appendices, each one of which is systematic and complete, the statistics are given upon which all computations are based. It is needless to state that the mathematical features, together with the maps and diagrams, are as elaborate as the other portions of the work.

A political lesson of the utmost consequence in its relations to the Fed-

eral Government is embodied in this report. The National Government accomplished in twelve years the solution, both in principle and in detail, of two great problems of internal improvement—protection from overflow and the deepening of the water on the bars—problems which had baffled all the efforts of four separate States for a century and a half. It is clear that the power which rules at the source of the great river must hold the channel, the delta and the mouths. Thus the Mississippi becomes at once the promise, the pledge and the bond of Union. "Whoever is master of the Mississippi is lord of the continent." The security of our national integrity must then be found, not only in constitutional provisions, congressional enactments, and in the coercive measures of war, but also in identity of commercial and industrial interests, supported by the vast possibilities of their indefinite development.

To return to our text.

An able reviewer says: "It is not too much to say, after a careful study of this report, that, as a work of science, it will not suffer by comparison with any in our language, while it is, in its special department, without a peer, and almost without a rival. It finds the whole subject of river hydraulics a confused congeries of discordant theories and untenable hypotheses, the offspring of insufficient generalizations. It leaves it a determined science, the result of wide observation of facts, acute and laborious combination and rigid and logical scientific analysis. Its authors may well be proud of their work, for it places them in the front rank of scientific men, and shows them to be the discoverers of a science, the first fruits merely of which appear in their deductions of the laws which regulate the flowage of the Mississippi."*

The work has been translated twice into German, twice into French, once if not twice into Italian, and once into Hungarian.

In 1865–'66, Humphreys published a voluminous report, entitled Examination of the Mississippi Levees. In 1875, General Humphreys, then the Chief of Engineers, published *Memoranda relating to the Improvement of the Entrance to the Mississippi River by Jetties*,† in which he enforced his views in favor of a ship canal. Elaborate diagrams were annexed. In 1878, Humphreys and Abbot published a reply to criticisms upon their work by Dr. Hagen, Director-General of Public Works in Prussia.‡ The tone of foreign criticism, with this exception, had been uniformly favorable and courteous.

We now pass from the consideration of Gen. Humphreys' labors as a man of science to view him as a soldier in the field. In this respect his skill as an engineer was of the utmost value. He had a quick eye for

* North American Review *ut supra*.

† Being Appendix 8, 12, of the Annual Report of the Chief of Engineers for 1875. Washington, 1875.

‡ Physics and Hydraulics of the Mississippi. Reply to certain criticisms made by Dr. Hagen, Director-General of Public Works, Prussia. Von Nostrand's Eclectic Engineering Magazine, No. cix, January, 1878, Vol. xviii.

topography, and foresaw with remarkable accuracy how far the peculiarities of the region through which he campaigned would be available for the purposes of marching, assault, or defence. Col. Paine, "the pathfinder of the army of the Potomac," has said: "For general as well as intimate acquaintance with the country in which he was operating, and the troops against whom he was engaged—in fact, the general relative situation of affairs—Humphreys was second to no other Union General."

In 1861, Humphreys was a Major of Topographical Engineers. He was placed upon the staff of Gen. McClellan, with the rank of Brigadier-General of Volunteers, and became the Chief Topographical Engineer of the Army of the Potomac. When the advance upon Richmond was under consideration, though it is not recorded that he advocated a direct advance, yet it is known that he favored the "Urbana route," in preference to the movement up the Peninsula. He was engaged at the siege of Yorktown, in the battle of Williamsburgh, and in the movements and operations before Richmond and to the James river in 1862. His services at Malvern Hill were most conspicuous. He closed the lines, or, in other words, posted all the corps except the Fifth, and one division of the Fourth. The dispositions which he made contributed to the successful results of that eventful day, while the neglect to shell a wood, as he desired, allowed its occupation by the enemy, from which they had to be driven by force.

On the return north of the Army of the Potomac, he was transferred from staff or engineering duty, to the command of a division of new troops, with which he pressed to Antietam, "marching with commendable activity," a march of more than twenty-three miles on a dark night to take part in the expected battle of the next day. After that battle he made a reconnoissance in the Shenadoah valley, which has been spoken of as "one of the finest and most thorough possible to be made, indicating the possession of every quality necessary to a thorough soldier."

At the battle of Fredericksburg, 13th of December, 1862, he personally led a charge, which for desperate valor has few equals in the annals of war.

When Sumner was directed to storm the heights above the town, he selected the divisions of French and Hancock for the assault.

The position to be carried had by nature strong defensive advantages. Between the canal—which had to be crossed—and the crown of the ridge of hills the space was covered by fences and buildings, while at the foot of the ascent proper to Marye's Heights a sunken road, running behind a high stone wall, afforded as perfect a defensive work as if planned and constructed by engineers. This line of defense was still further strengthened by fortifications in the rear, which rose tier upon tier, so that the Confederate infantry was enabled to deliver a concentric fire. Indeed the head of the assaulting column "seemed to propel itself into a yawning gulf of flame."

The first attack was made by French, with the Third Division of the Second Corps, with a boldness and steadiness that carried him to within

thirty or forty paces of the wall. He was badly repulsed, and withdrew, leaving twelve hundred dead and wounded out of about twice that number. The second attack was made by Hancock with the First Division of the Second Corps. His line broke within twenty-five paces of the wall. In the short space of a quarter of an hour two thousand and thirteen lifeless or mangled forms were added to the victims of the former attempt.

Humphreys was next sent over. Gen. Palfrey says: "Some of the very best fighting that was done at Fredericksburg was done by the Third Division of the Fifth Corps. The division was commanded by Gen. Humphreys, who was probably the best officer in the Army of the Potomac that day. He was a thoroughly educated soldier, possessed of a quick eye and a clear head, and a man of fiery energy. That the fighting his divison did was so good was due to him."*

He had but two brigades, one commanded by Col. Allabach, the other by Brigadier-General E. B. Tyler. Several of his regiments had never before been in battle. His men divested themselves of their knapsacks, haversacks and overcoats, and then moved across the canal. Humphreys in person formed the leading brigade in a ravine about three or four hundred yards from the stone wall, and then led the advance in line of battle, but found to his surprise that Couch's men were lying down behind a small fold in the ground about one hundred and fifty yards or less from the wall. He then ordered a bayonet charge, but failed to carry the wall, owing to the disorder into which his men were thrown by those who were lying on the ground several ranks deep. Upon turning back to his second brigade, he discovered that artillery had been placed by Hooker on the very ground his troops must pass over.† Quickly riding to every gun he put a stop to the firing, and led forward his second brigade, directing it to run over the men in front. Notwithstanding the confusion incident to the effort to obey this order, the onward impetus of the line carried it close to the wall, when a sheet of flame ran along its entire length, accompanied by a long roll of thunder, and wrapped the column in an embrace of fire. Twilight was fast deepening, and amid the thick mists of the bottom land every discharge was as brilliant as the trail of a rocket, thus adding to the grandeur and terrors of the scene.

Two horses were shot under the intrepid leader, who hastily mounted a third, and continued to ride about amid the rain of missiles, bearing a charmed life; his clothing was pierced and rent, but his person was unhurt. Every officer of his staff but one, his son, was dismounted, and his horse was badly wounded. In vain did Humphreys endeavor to halt his men as they turned slowly backward. In vain did he endeavor to remedy the disorder occasioned by the troops lying down whom he had been sent

* Antietam and Fredericksburg, by Gen. Palfrey. Scribner's Campaigns of the Civil War.

† Note to p. 232 of Campaigns of the Army of the Potomac, by Wm. Swinton. Appendix, Revision and Re-issue. Scribner, 1882. Humphreys' Charge on Marye Heights.

to support; in vain did he endeavor to induce them to rise and join in the charge, and with some bitterness he subsequently wrote that had they been withdrawn before he moved forward, a different result would have followed. Indeed, so near was he to carrying the wall and heights that the enemy were actually moving their guns out of the batteries, and on the right they were beginning to quit the wall.*

"His division, like the third breaker upon a beach, left its traces of blood and wrecks a few paces further on, and nearer to the enemy than the preceding two, lingered longer, strove harder to maintain itself so far, and to accomplish the impossible. Finally it withdrew, singing in chorus, to show that although shattered physically, morally its spirits were unshaken. His charge will yet be blazoned forth in history as one of the noblest efforts of Northern resolution, or, as he expressed it, of one of Kearney's exhibitions of valor "magnificent."†

The reckless bravery of Humphreys as displayed on this and other occasions, proved that he had a keen relish for conflict. Not that he delighted in slaughter, or had the slightest trace of ferocity in his nature, but the romantic love of peril and adventure, the wild rapture of battle (*certaminis gaudia*), the thrilling occasion, the mighty shock of armed men, the encounter of mind with mind, of strategy matched against strategy, of force directed against force, the issues trembling in the balance, and the possible grand result, aroused all the tremendous energies of his intellect, and transformed the quiet scholar into the very embodiment of resistless heroism. Like the war horse, in Job, he mocked at fear and was not affrighted; neither turned he back from the sword. "Of all the sublime sights within the view and comprehension of man," he wrote, "the grandest, the most sublime, is a great battle. Its sights and sounds arouse a feeling of exaltation, compared to which, tame indeed is the sense of the sublime excited by all other great works, either of God or man." And again: "That which makes the thrilling interest of a battle is the personal incident. A battle so lifts a man out of himself that he scarcely recognizes his identity when peace returns, and with it the quiet occupations."

He was breveted Colonel United States Army, for gallant and meritorious services, with a commission bearing the date of the battle of Fredericksburg, and was warmly pressed by Burnside for a full Major-General's commission. His promotion, however, was of later date.

His next services in the field were at Chancellorsville, where he commanded the Third Division of the Fifth Corps, then commanded by Meade. He was posted upon the extreme left, where, near the brick house called the Chancellor house, he was sharply engaged with the enemy. In his testimony before the Joint Committee of Congress on the conduct of the war, he declared that he probably knew less in regard to the battle of Chancellorsville than any other battle he ever took part in. With other

* Letter of Gen. Humphreys to Wm. Swinton, May 10, 1866, *ut supra*.
† De Peyster.

distinguished officers he strongly disapproved of the order by which the army was withdrawn from its advanced position and compelled to fight a defensive instead of an offensive battle.* Many years after, in commenting on this battle, Gen. Humphreys said: "The Army of the Potomac did not fight at Chancellorsville. The Eleventh Corps, badly posted, was permitted to be surprised by overwhelming numbers, and routed. The Third Corps, aided by artillery, posted by Pleasonton, threw itself into the breach, arrested the forward movement of the enemy, and the next morning was allowed to sustain the attack of Lee's whole force for several hours, losing in killed and wounded a large part of its numbers. It was of course obliged to fall back upon the other portion of the army, the First, Second, Fifth and Twelfth Corps, in position near by, just in rear of Chancellorsville. Only parts of some of these corps were partially engaged in covering the withdrawal of the Third Corps. Sedgwick advancing from Fredericksburg, with the Sixth Corps and one Division of the Second Corps, was attacked by Lee, and forced back over the Rappahannock. Lee, in this operation, had 60,000 men, Longstreet's Corps being absent; Hooker not less than 90,000 men. It is not surprising, then, that the Army of Northern Virginia should have made a false estimate of its prowess, or at least of that of the Army of the Potomac."†

Shortly after the battle of Chancellorsville, Gen. Meade, in a private letter, dated May 19, 1863, wrote as follows: "I have lost nearly a division by the expiration of service of the two years and nine months men, so that I have had to break up Humphreys' Division, and he is going to take command of the division recently commanded by Gen. Berry in Sickles' Corps. I am very sorry to lose Humphreys. He is a most valuable officer, besides being an associate of the most agreeable kind."

The intimate relations between the two friends was, however, soon to be reëstablished. A gentleman, whose knowledge is undoubted, writes: "The fact stands that when Gen. Meade was placed in command of the Army of the Potomac, the first man he thought of, and whom he called to his assistance was Gen. Humphreys. The reason why he was not his Chief of Staff at Gettysburg was solely due to Humphreys' own desire to command his division in the coming engagement. He thought that at that particular crisis he could render greater assistance in the position he then held. In addition to this he always had a great partiality for commanding troops, especially in a fight."‡

At Gettysburg, where Humphreys commanded the Second Division of the Third Corps—a division which had always been a favorite—he displayed not only coolness and valor, but consummate skill in handling

* Report on the Conduct of the War. 1865, Vol. I, pp. 61-65.

† Address of Maj. Gen. A. A. Humphreys on the Military Services of the late Maj. Gen. George Gordon Meade, at the Meade Memorial Meeting of the citizens of Philadelphia, Nov. 18, 1872. Washington, D. C., 1872.

‡ Letter of Col. George Meade to the writer. Testimony of Gen. Humphreys before the Committee on the Conduct of War. Report on the Conduct of the War, 1865, Vol. I, p. 388.

his troops. As he pressed forward to the town of Gettysburg on the evening of the first of July, he was informed that the enemy had made their appearance there in force; that the First and Eleventh Corps had been very hotly engaged, and that Gen. Reynolds had been killed. He was directed to follow a road about two miles west of the main one, and learned that Lieutenant Colonel Hayden, Assistant Inspector-General of the Corps, was present with a gentleman from Gettysburg, who acted as a guide for the route that Gen. Sickles wished him to take. Contrary to Gen. Humphreys' views who wished to move to the right so as to join Howard's left, Col. Hayden insisted that Gen. Sickles wished him to approach by the Black Horse Tavern road, which led towards the left directly to the enemy. With many misgivings Humphreys obeyed. His movement occupied considerable time owing to the crossings of Marsh run. He took the precaution of directing his column to move quietly as it approached the road, and to close up, as he expected to fall in with the enemy. He soon found the enemy posted in force, but unaware of his presence. He might have attacked them at daylight with the certainty of at least temporary success, but as he was three miles distant from the remainder of the army, he believed that such a course would be inconsistent with the general plan of operations of the commanding General. As soon as he ascertained the exact condition of things, he retraced his steps and bivouacked near Gettysburg about 1 A. M., on the 2d of July. This delayed him several hours, and greatly fatigued his men. It was a moonlight night, but hazy. The reference, which Gen. Humphreys makes to what others have admired as an exhibition of remarkable skill in extricating his division from a dangerous position, is one of characteristic modesty. He says: "It shows what can be done by accident. If any one had been directed to take a division to the rear of the enemy's army and get up as close as I did unperceived, it would have been thought exceedingly difficult, if not impossible to do it unnoticed."*

It was subsequently ascertained that Col. Hayden had entirely misapprehended Gen. Sickles' order, and that it had never been intended that the division should march by way of the Black Horse Tavern.

The next morning, the 2d, his division, forming the right of the Third Corps, was massed on a ridge of elevated ground between Cemetery Hill and Round Top, some four or five hundred yards in advance of the general line. This placed the entire corps in great danger. In the afternoon he was fiercely attacked in front and flank, and sustained some of the hottest fighting of the day. While under a heavy fire of infantry and artillery—"I have never been under a hotter artillery and musketry fire combined," he states—just at the moment he found it necessary to get his own artillery out of the way as quickly as possible, and advance his whole line to pour a fire upon the charging enemy, he received an order from Gen. Birney informing him that Gen. Sickles had been wounded, and that he

* Testimony of Gen. Humphreys. Report on the Conduct of the War. 1865. Vol. 1, p. 389. *Ut supra*, p. 390.

had succeeded to the command of the Corps, and that his division was going to fall back and form in line extending towards Humphreys' right from the Round Top ridge in rear of and oblique to his present line, and that he must change front and form on that line. In complying with this order, he had to change from front to rear. While making the movement, the troops on his left failed to stop on the Round Top ridge, but passed beyond it. Humphreys instantly extended his line to the left to close up the aperture, and was attacked on his flanks as well as on his front. For a moment he thought the day was lost. Just then he received an order to fall back to the Ridge, which he did slowly and in good order, stubbornly contesting every inch of ground, and suffering a very heavy loss. "I did not fall back rapidly," he says, "because I disliked to fall back at double quick before the enemy, and besides I did not suppose I could rally my troops, or that any troops could be rallied at the place where the line was to be formed, if the movement backward was made rapidly." He reached the ridge, leaving three guns behind, the horses of which had been killed, and rallied the remnants of his division. Quickly wheeling, as the enemy came up, he poured in a fire, and his troops, joining in with the Second Corps, drove back the foe, recovering the lost guns. His men did not wait for orders, but dashed impetuously forward, and as there were so few of them, he went with them to bring them back before they got too far from the main line. By that time it was dusk, and the fighting ceased for the day.*

On the third day, while moving into position, he was fiercely shelled by the enemy, and about four o'clock in the afternoon formed his division into columns of attack, and prepared to advance. While in this position he lost some valuable officers, as well as men. No orders were given to advance, and as the enemy did not renew their attack, which was the great feature of the day, he returned to his position on the left, where he remained until the army moved from Gettysburg.

The services of Humphreys in this battle added greatly to his renown. His skillful handling of his troops and his desperate conflict and coolness in the peach orchard, where his son was wounded at his side, added new laurels to his chaplet, and resulted, on the 13th March, 1865, in a brevet as Brigadier-General United States Army.

Four days after the battle of Gettysburg he accepted the position tendered him by Gen. Meade, as Chief of Staff of the Army of the Potomac, which he held from 8th July, 1863, to 25th November, 1864. He bade farewell to his command in these well-weighed words of commendation: "In parting from this celebrated division, after having commanded it for the brief period of fifty days, I trust that I may be excused for expressing my admiration for its high soldierly qualities. It is impossible to pass it in review even without perceiving that its ranks are filled with men that are soldiers in the best meaning of this term, and that it possesses in the

* *Ut supra*, p. 392. Swinton's Army of the Potomac. Gettysburg, the second day, pp. 342-355.

grade of commissioned officers, men whose skill, courage and accomplishments would grace any service."

As Chief of Staff he was engaged in the action of Manassas Gap; the Rapidan operations; the action on the Rappahannock and the combat of Bristoe Station; the operations of Mine Run, the battles of the Wilderness, Spottsylvania, North Anna, Tolopotomy, Cold Harbor, Petersburgh, the Weldon Railroad, Peebles' Farm and the Boydton Plank Road.*

During the fall and winter of 1863–'64, he thrice planned the surprise and destruction of Lee, but his plans were frustrated partially by disobedience of orders and partially by modifications to which he did not assent, and the attempts were barren of results. As he has modestly refrained from specific statements in his little book, "Gettysburg to the Rapidan," the facts can be gathered only from sources not yet public. He served his chief with absolute fidelity and staunch friendship, but his services, though of great importance, could not be fully appreciated by the public. A competent military critic has remarked that "what Von Moltke was to the King of Prussia, afterwards Emperor of Germany, what Blumenthal was to the Crown Prince, Humphreys was to Meade in many respects."

On the 26th November, 1864, he resigned his position as Chief of Staff, to succeed Hancock in the command of the Second Corps, or, properly speaking, the combined Second and Third Corps, a fusion of which he did not approve as destructive of the *corps de esprit* of both.†

In a private letter of General Meade, dated November 25, 1864, he says: "Hancock leaves us to-morrow, he having a leave of absence, after which he will be assigned to recruiting duty. Humphreys takes his place. The change in my position has rendered it unnecessary to have an officer of Humphreys' rank as Chief of Staff. I deemed it due to him to suggest his name as Hancock's successor."

On assuming his new command, he said: "It is natural that I should feel some diffidence in succeeding to the command of so distinguished a soldier as Major-General Hancock. I can only promise you that I shall try to do my duty and preserve your reputation unsullied, relying upon you to sustain me by that skill and courage which you have so conspicuously displayed on so many fields."

From that time forth, his career is marked by a series of brilliant successes. He now had a fair opportunity to display his capabilities as a general.

The winter of 1864–'65 had been severe and the Confederate army suffered much from want of food. Their supplies were brought by wagons from Hicksford on the Weldon Railroad, forty miles south of Petersburgh. To break up this route of supply, Humphreys was ordered to coöperate with the Fifth Corps, which, in turn, was to support Gregg's cavalry of the Army of the Potomac. On the 6th of February, Humphreys began his operations by throwing a bridge across Hatcher's run. On the 6th, a se-

* Statement of services, *ut supra*.

† "Bird's-Eye View of the War," by Col. Dodge.

vere action took place, which resulted in the extension of the Federal entrenchments to the left as far as Hatcher's run at the Vaughn Road crossing. Humphreys was on the extreme left, with the Fifth Corps massed in support. On March 25th, Lee made his desperate attack upon Fort Stedman, a blow aimed at the Union base of supplies at City Point, which, though well conceived and gallantly executed, was frustrated by the good conduct of Gen. Hartranft. On the same day Humphreys and Wright, availing themselves of the opportunity thus offered, attacked Lee upon their respective fronts, and accomplished most valuable results, which contributed to the success of Wright's assault on the morning of the 2d of April, by which the enemy's entrenchments were carried, and Lee forced to abandon his lines. On the 30th, Sheridan had his fight at Dinwiddie Court House, and on this day when Warren met with temporary disaster, while advancing to cut Lee's communication with his extreme right, Humphreys suddenly launched his first division under Miles against the successful Confederates, striking their front and flank, "withering their triumph," driving them back, capturing three hundred prisoners, and advanced to the White Oak road, the first time that this important thoroughfare had been reached by our troops. On the 1st and 2d of April, the Second Corps carried the works in their front, and Miles again won laurels at Sutherland Station.

On the evening of April 2d, Lee began his retreat. Early on the morning of the 3d, Petersburgh was occupied by General Willcox, and at 8 A. M. Richmond fell, and the great pursuit began; the cavalry, under Sheridan, supported by the Fifth Corps under Warren, leading the advance, while the Second Corps followed, rapidly building bridges and repairing roads. Sheridan, with Crook's Division and the Fifth Corps, arrived, at about 4 P. M., at Jetersville, and entrenched there, so as to dispute Lee's attempt to join Johnston. On the morning of the 4th, Lee was at Amelia Court House, but instead of attempting to break his way through Sheridan's lines, dallied there to bring up his baggage. The delay was fatal. On the 5th, the Second Corps reached Jetersville, followed by the Sixth. In the evening, Lee finding the forces in his front too strong to be attacked, turned north, and pushed towards Farmville in search of supplies. Early on the 6th, the Army of the Potomac moved out, "like the ribs of a fan," from Jetersville, in the direction of Amelia Court House, where they expected to meet the Army of Northern Virginia in battle array. But, instead of awaiting them there, Lee had nearly slipped by their front westward. While Sheridan and his immortal cavalry, supported by the Fifth Corps, were dealing with the advance bodies of Lee's army, Humphreys was fighting and driving the compact and well-organized forces that remained, hanging persistently upon their flank and inflicting wounds from which, as has been said, "Lee bled to death." The conspicuous service rendered by Humphreys was in retarding and crippling the retreat of the main body, thus rendering it possible for the cavalry to head off the advance. On the 6th, at 8 A. M., Humphreys caught up with the

enemy at Flat creek, his men partly fording the stream, armpit deep, and partly crossing it upon a hastily improvised bridge, and after having been engaged in seven stand-up fights over a distance of fourteen miles, and carried several partially entrenched positions defended by artillery, closed the day with a sharp action at nightfall with Gordon's division at Perkinson's Mill, near the mouth of Sailor's creek. In the meanwhile Ewell's division, "split off by Humphreys," fell into the hands of the cavalry at Little Sailor's creek, and surrendered about six thousand men.*

During the night, the enemy again slipped away, but in the morning, shortly after daylight, Humphreys swept down upon High Bridge, and secured the only viaduct across the Appomatox which the Confederates had not burned or succeeded in destroying in their hurried flight. Four miles further on, at the Heights of Farmville, or Cumberland Church, Humphreys again fell upon a solid body of the enemy, and as the roar of his guns burst upon the ear, Lee is reported to have said, "There is that Second Corps again." Here Humphreys held him until night, having sent word to General Meade that Lee's whole remaining force, about 18,000 infantry, had been overtaken, and suggesting that a corps should attack Lee from the direction of Farmville, four miles off, at the same time that the Second Corps attacked from the opposite direction. The river near Farmville proved impassable, and Humphreys was obliged to contend with the enemy without support. The enemy's position was naturally strong and well entrenched, and though Humphreys failed to carry it, he clung so persistently to his purpose as to succeed in detaining Lee there until night, a loss of invaluable time which he could not regain by night marching. He therefore lost the supplies awaiting him at Appomatox station, and Sheridan with his cavalry, and Ord with the Fifth and Twenty-fourth Corps were enabled to post themselves across his path at Appomatox Court House, about fifty miles further on.

Had Humphreys failed to secure High Bridge, had no infantry crossed the Appomatox on the 7th, Lee would, in all probability, have effected his escape. He could have reached New Store that night, Appomatox station on the afternoon of the 8th, obtained the rations there, and moved that evening towards Lynchburg. A march next day, would have brought him

*I am under obligations to Brevet Major-General (S. N. Y.) J. Watts De Peyster for assistance in the preparation of this account. In addition to the examination of several papers written by himself, which he kindly placed in my hands, I have studied the maps in his elaborate work, La Royale, The Grand Hunt of the Army of the Potomac, which was printed for private circulation, the value of which is acknowledged by General Humphreys in the preface to "The Virginia Campaign of '64-'65."

The remaining authorities are: "With General Sheridan in Lee's Last Campaign;" "The Virginia Campaign of '64-'65;" "Scribner's Campaigns of the Civil War:" The Histories of the Civil War, by Draper, Lossing, and Harper's General History; Swinton's "History of the Army of the Potomac;" with a number of special papers, addresses and reports. I must also acknowledge the assistance of Major Jos. G. Rosengarten and Col. Jno. P. Nicholson.

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to Lynchburg, where he would have been safe.* The value of Humphreys' services in crossing the Appomatox and detaining Lee all day at the Heights of Farmville or Cumberland Church will be appreciated, when it is remembered that Ord's two infantry corps did not reach Appomatox Court House until 10 o'clock in the morning of the 9th of April, and that it was the sight of Ord's infantry supporting Sheridan, that convinced Gordon that further fighting was useless and escape impossible.

About half-past eight o'clock on the evening of the 7th, when still in close contact with Lee, as has been described, Adjutant-General Seth Williams brought to General Humphreys Grant's first letter to Lee asking the surrender of Lee's army. This letter Humphreys was requested to have delivered to General Lee. He sent it at once through his picket line, at the same time authorizing a truce for an hour, oenable the enemy to gather up their wounded. At this time the opposing troops were but a few hundred yards apart. Lee's answer was brought back within an hour, and General Williams started at once to return to General Grant at Farmville by the circuitous route of High Bridge. The next morning Humphreys resumed the pursuit. While on the march, Grant's second letter to Lee was brought to Humphreys, who sent it to Lee through Fitz-Lee's cavalry rear guard which was then close in Humphreys' front. Lee's answer was received by Humphreys about dusk, as he halted for a three hours' rest, two miles beyond New Store, after a march of twenty miles. He again pushed forward, but after a march of twenty-six miles, was compelled to halt his column at midnight, on finding his men dropping out of the ranks from want of food and fatigue. On the morning of the 9th Humphreys received Grant's third letter to Lee, which was delivered to him in person by Colonel Whittier, of Humphreys' staff. Lee's answer was delivered by the hands of Colonel Whittier to General Meade, who forwarded it to General Grant, who had then left the route followed by the Second and Sixth Corps, and taken a cross-road which led to Appomatox Court House, and along or near the routes of Sheridan and Ord. Had Grant remained on the route of the Second and Sixth Corps, the surrender would have taken place before midday. As it was, Grant having ridden forward, the meeting between himself and Lee did not take place until one o'clock P. M., and the surrender of the Army of Northern Virginia was not announced to the Army of the Potomac until four o'clock. The remainder of this celebrated correspondence passed through the lines of General Sheridan.†

In the meantime General Humphreys, closely followed by the Sixth Corps, pressed forward, and began to overtake Longstreet, when he received two earnest verbal requests from General Lee, by a staff officer, with a flag of truce, not to press forward upon him, but to halt, as negociations were going on for a surrender. As Humphreys had been notified

* The Virginia Campaign of '64-'65, p. 391; Scribner's Campaigns of the Civil War, Vol. xii.

† The Virginia Campaign of '64-'65, p. 394.

that the correspondence was in no way to interfere with his operations, he twice sent word to Lee's staff officer that the request could not be complied with, and that he must withdraw from the ground at once. At this time, he was in full sight on the road, not a hundred yards distant from the head of the Second Corps. Humphreys at once formed his corps for attack, the Sixth Corps formed on the right, which, at the moment it was about to begin, was suspended by the arrival of General Meade, who granted a truce for an hour. Hostilities were never resumed. The Great Civil War was at an end.

These facts are sufficient to illustrate the relentless character of Humphreys' pursuit, and attest his ability as a corps commander in handling men worn out by hunger, fatigue, long marches and severe fighting. They fitly close his active military services in the field.

In the grand review of the Army of the Potomac, at Washington, the Second Corps participated, and one of the noticeable features of the occasion was the appearance of General Humphreys' staff mounted upon white horses, a delicate compliment to the noble grey who had carried him so gallantly through the fatigues of the march and the perils of battle. The old war-horse still lives, with but slight abatement of her wonted spirit.

General Humphreys was in command of the District of Pennsylvania, in the Middle Department, from July 28 to December 9th, 1865.

From December, 1865, to August of the following year, he was in charge of the examination of the Mississippi levees, a work rendered necessary by the neglect and damage of the war.

On August 8, 1866, he was appointed to the command of the Corps of Engineers, with the rank of Brigadier-General and Chief of Engineers, serving in this capacity until his retirement from active service, at his own request, on June 30, 1879. He thoroughly organized this branch of the service. The work of the general office was divided into four divisions, and an officer of special fitness placed in charge of each, while officers of rank and experience were assigned to important districts and duties.

He served as a Member of the Lighthouse Board, from 1870 to 1874; of the Commission to examine into canal routes across the Isthmus connecting North and South America, from 1872 to 1877; of the Board on Washington and Georgetown Harbor improvements from 1872 to 1873; of the Revising Board of Bulkhead and Pier Line of Brooklyn from May, 1872, to June, 1879, of Staten Island from August, 1878, to June, 1879, and of Hudson river (Troy to Hudson), June, 1877, to June, 1879; of Board for Survey of Baltimore Harbor and adjacent waters from May, 1876, to June, 1879; of the Washington Monument Commission from January, 1877, to June, 1879; of the Advisory Board to Massachusetts Harbor Commissioners from January, 1877, to June, 1879, and of the Examining Board of Moline Water Power Company contracts during 1877.*

In the civil duties appertaining to his profession he was as eminent as in

* Statement of Services, *ut supra*.

his military duties in the field. In 1857 he was chosen a member of the American Philosophical Society held at Philadelphia, Pa., of which both his grandfather and father had been members, and of the American Academy of Arts and Sciences of Boston, Mass., in 1863; a corporator of the National Academy of Science in 1863; an Honorary Member of the Imperial Royal Geological Institute of Vienna in 1862, of the Royal Institute of Science and Art of Lombardy, Milan, Italy, in 1864; and corresponding member of the Geographical Society of Paris, and of the Austrian Society of Engineer Architects, and an Honorary Member of the Italian Geological Society in 1880. The Degree of LL.D. was conferred upon him by Harvard College, July 15, 1868.

After retirement from the Bureau, the last intellectual labor performed by General Humphreys was in the composition of two books, which together constitute a military classic and a mine of important matter relating to the history of the war—"The Virginia Campaign of '64–'65," and "From Gettysburg to the Rapidan"—the latter being, properly, an introduction to the first.

The amount of work bestowed upon them was immense, and the results exhibit extraordinary power of intellectual compression. Indeed for many they will prove too concise and dry to be interesting, but no one can be at a loss to understand the operations described. With entire freedom from ostentation or rhetorical parade he closes the former book in these words: "It has not seemed to me necessary to attempt an eulogy upon the Army of the Potomac or the Army of Northern Virginia." These were his merits as a writer—precision, brevity, simplicity—a style suited to his subjects, but not one to attract the general reader.

One of the most gratifying personal tributes to General Humphreys was the presentation of a memorial sword by the citizens of Philadelphia, on the evening of the 4th of July 1866,* at the building of the Union

* The Sword presented to Major-General A. A. Humphreys, U. S. Army, by his fellow-citizens of Philadelphia, 1866. *E Pluribus Unum.* Liberty and Union

This on one side; on the other side:

Yorktown, April 15th, to May 4th, 1862.
Williamsburg, May 6th, 1862
Chickahominy, May and June, 1863.
Malvern Hill, July 1st, 1862.
Fredericksburg, December 13th, 1862.
Chancellorsville, May 1863
Gettysburg, July 1st, 2d, 3d, 1863.
Manassas Gap, July 1863.
Rappahannock, October to November 7th, 1863.
Mine Run, November 29th to December 3d, 1863.
Rapidan, February 1864.
The Wilderness, May 6th and 7th, 1864.
Spottsylvania Court House, May 9th to 20th, 1864.
The South Anna, May 21st to 25th, 1864.
Totopotomy, May 28th, 29th, 30th, 1864.
Cold Harbor, June 1st, 2d, 3d, 1864.
Petersburgh, June 16th, 17th, 18th, 1864.
The Mine, July 30th, 1864.
The Weldon Railroad, August 18th, 25th, 1864.
The Boydtown Road, October 27th, 28th, 1864.
Hatcher's Run, February 4th, 5th, 6th, 1865.
The Fall of Petersburgh, March 25th to April 3d, 1865.
Pursuit of Lee.
Sailor's Creek, April 6th, 1865.
The Heights of Farmville, April 7th, 1865.
The Surrender of Lee, April 9th, 1865.

League. From his boyhood, he had been almost a stranger to his native city, and was personally unknown to many of her leading citizens, but his distinguished scientific and military services had become a part of the imperishable history of the nation, and entitled him to this tribute of respect, affection and gratitude. The lofty conception which he entertained of his noble profession, inspired the words with which he received the gift: "The sword is regarded as the emblem of manly virtue, of a just mind, a courageous heart, and a gentle spirit. No token of your regard for me as a soldier and as a man could be more acceptable, and, perhaps, I most fittingly acknowledge your gift in saying that I shall try so to wear this beautiful embodiment of all the qualities a sword should possess, that its spotless blade may never be stained, nor its brilliant lustre dimmed."

This was his ideal of the model soldier. It is not too much to say that in thought, word and deed he fulfilled and illustrated it.

At the Meade memorial meeting of the citizens of Philadelphia, held on the 18th November, 1872, Gen. Humphreys delivered an address upon the military services of General Meade. It is an able and luminous review of complicated operations, and without the aid of turgid adjectives or pretentious nouns, embodies the highest tribute ever paid by a military critic to a great commander. After a thorough discussion of the question why Meade did not capture Lee after the battle of Gettysburg, General Humphreys declares: "After a careful examination of the subject so far as I am capable of forming an opinion, I am led to the conclusion that Meade, at Gettysburg, had a more difficult task than Wellington at Waterloo, and performed it equally well, although he had no Blücher to turn the scale." From such a critic what praise could be higher, and yet what could be simpler in point of expression?

In drawing to a conclusion this imperfect review of the career of Gen. Humphreys, it will be proper to quote a few carefully selected expressions of opinion by men qualified by their public positions and professional attainments to form a competent judgment.

Gen. De Peyster says: "In the death of A. A. Humphreys, the United States lost without question their most thoroughly scientific engineer and soldier and general combined; illustrious in every branch of the service which he adorned; equally able as an engineer for the use of inert materials, and as a general for the handling of living masses, and as a soldier for setting an example of intrepidity, * * * * * in topography, geodesy and dynamics he was equally eminent, and his pen was not more capable of demonstrating the laws which govern natural cataclysms than his sword in cutting the Gordian knot of difficulties by his bold strategy and bolder tactics."

Gen. Hancock has declared "That if he were an absolute monarch, and could dispose of a large army; he knew of no one whom he would place at its head with such perfect confidence as Humphreys."

Another major-general of distinction has said: "Humphreys' leader-

ship and soldiership were so unobtrusive that the country was not aware of what an able man it possessed in him."

"General Humphreys," wrote a gallant soldier, afterwards occupying an important civil position, "holds a place in my estimation as a soldier whose skill, bravery, and modesty are second to none, and whose real service was infinitely more valuable than that of many officers more talked about in the newspapers."

Another writes: "If Humphreys had enjoyed a more influential position the Northern people would have enjoyed many more occasions to rejoice. This must have been the case if the power of handling large bodies of troops; if rare science and its test—application; if calmness and clearness of judgment under fire; if energy, undaunted courage and self-forgetfulness in view of results have any effect upon military operations."

Major Bundy styled him "a scientific soldier, a wise and safe counsellor."

A military critic as far back as in 1869, wrote: "As a fighting division commander, as a proficient in the handling of a corps; as a consummate chief of staff of the Army of the Potomac; as an intrepid gentleman; as a faithful soldier, and as a remarkable engineer, Gen. Humphreys had no superior. His survey and reports upon the Mississippi will be as proud a memorial of his engineering capacity as his military record, beginning with the Florida war, in 1836, is a record which is without a stain, as rich in historic deeds and services as the sacred shield of Lancelot."

An ardent admirer and devoted friend pays the following tribute: "A great and at the same time a good man, who attained the ripest age with undiminished faculties; a magnificent soldier who combined the calmest intrepidity with executive ability in battle, a mind capable of working with the nicest precision amid the wildest churme of conflict under exceptional circumstances of peril; a scientist of views most comprehensive and practical; of knowledge vast and developed."

These are the amaranths with which his companions in arms have crowned his name.

In private life, General Humphreys was courteous, kind, gentle and affectionate. His love and enjoyment of home were sincere and unaffected. He married, June 19, 1839, Rebecca, the youngest daughter of Henry Hollingsworth, one of the mostre spected citizens of Philadelphia, and had two sons and two daughters, of whom the former and one daughter survive. To him, wife, daughters, sisters, were not merely the objects of affection, but the embodiment of that perfect womanliness at whose shrine he knelt in reverenee. His mind idealized all that it dwelt upon and both absorbed and imparted radiance. He had a refined and cultivated taste for art and literature and in some respects was fastidious to an extreme degree.

His attachments to the home of his ancestors were strong and peculiar. No rage for modern improvement or convenience could ever induce him to change the structure or arrangement of the old and strange house he had inherited, jumbled together with the additions of several generations. Its lowly roof and straggling sheds embowered in vines were sacred. The

ivy that clambered about the windows, the venerable chestnut trees, the hirsute shrubbery, the old pump, surrounded by a hedge of lilacs, were the objects of his interested care. In the quiet burying-ground on the hill, I have seen the great soldier, whose fame had penetrated Europe, bend in respectful silence over the stone that marked the grave of some forgotten relative, or have listened, as he trod the well-loved fields of his childhood, to his recollections of those joyous days.

Such was the man. As simple in his greatness as he was great in his simplicity; of noble strength in body, heart, and brain, a union of opposites, a man who had devoted his whole life to the public good, and yet one of whom the public knew but little, partly because of his modesty, partly because his favorite studies were abstruse and recondite, but chiefly because he had none of the instincts of the politician, and scorned the artifices by which so many rise to popularity and fame.

He died on the 27th of December, A.D. 1883, in the seventy-fourth year of his age, while seated in his chair, without pain, and without a struggle.

"The best death," said the great Roman, "is that which is the least expected."

Fellow-members of the American Philosophical Society—In the bright galaxy of names which adorn our rolls there are stars of the first magnitude, whose glories have fixed the gaze of nations. Historians, statesmen, jurists, physicians, soldiers and philosophers—our great men have walked upon the high places of the earth. Their exertions have manifested the noblest intellectual power; their industry has tilled every field of activity; their studies have sounded every depth of knowledge; their daring zeal has penetrated to the remotest bounds of science; their devotion has made willing sacrifice of property and life; their success has won the highest meed of honor. Our Franklin, our Rittenhouse, our Bartram, our Wistar, our Kane, our Binney, our Sharswood, and he, whose recent death we all deplore, that grand old man, whose noble life was spent in acts of public usefulness and private benevolence which have endeared his name and consecrated his example—our Price—are they not all men of whose achievements we can boast without affectation, of whose deeds we can speak with pardonable pride?

Among these we now enroll the name of Humphreys. No chiseled marble preserves his lineaments, no lofty columns proclaim his worth, no demagogues attempt to conjure with his rod, but long after the fierce passions of our civil strife shall have burned themselves to ashes, long after his services to the cause of the Union and free government shall have risen to their proper place in military annals, when Oblivion shall have wrapped Secession in her mantle, and fraternal affection shall have buried the weapons of war, the memory of his scientific labors will live as his most enduring monument. He tamed the raging of the floods; he snatched from devastation the most fertile and magnificent valley in the world—the seat of future empire—and opened up the great Father of Waters to the commerce of the globe.

Let us add with pride—he was a Pennsylvanian and a Philadelphian.

Biographical Notice of Henry M. Phillips. By Richard Vaux.

(Read before the American Philosophical Society, Dec. 19, 1884.)

It rarely happens that a marked or lasting impression is made on the public mind by merely professional men. Devoted to the consideration of principles of paramount importance intrinsically and relatively, they are only applied in their direct operation within a limited circle. It is therefore those larger spheres, the arenas in which achievements are of signal importance, both to direct thought and excite actions that are not usually accessible to those trained in special studies, and who devote their powers to circumscribed mental efforts.

The legal training, while it is the best foundation for the highest successes in public life, and especially qualifies for a participation in the responsible duties of public affairs, if exclusively absorbed in professional duties fails to imprint itself on the pages of history. The brush, the pencil, and the chisel, attaining immortality, in some sort deal with universal law, formulated in objective teachings.

The lawyer reaches the highest professional eminence when he unites general knowledge with skill, learning, and the careful study of the principles of jurisprudence. Assiduous and unremitted application is the absolute essential for such triumphs. One finds in the history of statesmen, who have gained personal and public renown, and who rank with the great men whose posthumous fame lives in later generations, that their first preparations were in the study of the Pandects, the Institutes, the Civil and the Common law. Yet these names are unfrequent. The sword and the sceptre have cut into the tables of historic stone, the immortality of these rulers of peoples, and great leaders of victorious armies. The forum is the arena of peaceful antagonisms and contests in which the weapons are didactic skill, logic, reason and oratory.

Victories thus and there won are not declared by the display of ostentatious acclaim. In the quiet assertions of the deliberate and calm dominion of legal right, and ascertained justice, the supremacy of law is honored.

These reflections are eminently appropriate as preparatory to the notice of the death of one of our members, who, as a lawyer and a citizen held a pronounced position at the Bar of Philadelphia, and in public estimation.

Henry M. Phillips was born in Philadelphia, on the 30th of June, in the year 1811. Without large wealth, and its surroundings and influence, the lad early evinced a zeal and devotion to the shaping of his own career, which attracted even more than passing comment. He was a pupil in the most prominent school of that day, the "High School of the Franklin Institute." His quickness in acquiring knowledge was the leading trait in his academic life. There was apparently no trouble in his mastery of the subjects taught. It may be said that he ran through his course, until at its close he was with the foremost among his fellows.

There was no unanimity in the discussion of the pursuit best suited to the youth who had so early finished his school life. His father, a lawyer of remarkable prominence, and the acknowledged leader of the criminal bar of that day, did not wish his son Henry to study law. There were three sons, and it was thought but one should adopt the vocation of the father. But Henry, depending on his own ability as he measured it, was not satisfied till he became a student in his father's office. Before he had attained his majority, only twenty years of age, he was admitted to practice at the Philadelphia Bar.

It would be difficult now even to guess at the feelings of this young man who was thus placed in at least a trying and not very promising position, at his age, at that day, as an attorney at law in Philadelphia.

The Bar of Philadelphia was then admittedly the most remarkable of the law associations on this continent. It had become a popular adage, that no unsolvable problem would puzzle a Philadelphia lawyer. The Bar was lustrous with the most brilliant minds, and the roll of its members embraced not a few of the great jurists of that time. Masterly ability, profund learning, a high order of forensic eloquence, marked the golden age in its history.

Young Phillips at once began his legal career. The better to learn, he accepted the position of clerk in the Court of Common Pleas, presided over by a judge who has left a record of the most thorough mastery of jurisprudence, and wonderful ability. Judge King's name has few, if any, successful rivals in the profound respect of the bench and the Bar.

Under such daily tuition Mr. Phillips absorbed the principles of the law, and learned the truest method of their application. He became both an adept in practice, and the proper relations of precedents to cases. He was thus equipped for the contest before courts and juries. Very soon he held an assured place, and at the criminal bar and in civil courts he secured a substantial standing.

For nearly thirty years he advanced with progressive steps, till he reached the level of the leaders in his profession. The opinion of his brethren, as expressed at a meeting of the Bar, held October last, to honor his memory, is probably the best, if not the truest estimate of his professional and personal character that can be given.

This minute was unanimously adopted at that meeting:

"The death of Henry M. Phillips impels a sincere manifestation of the unfeigned sorrow of the Bar of Philadelphia. He was a man of rare qualities; a lawyer of striking and marked character; a friend of tried and true earnestness; a citizen of untiring devotion to all the duties imposed; faithful to every trust; of large and liberal views; he rose to a high rank in his profession as the associate of the great lawyers of this Bar, and was rightfully recognized as one of the foremost citizens of Philadelphia.

"The quickness and activity of his mind, his wonderful faculty of seizing, as by intuition, the strong points of his case, the force with which he elucidated them, the capacity for absorbing the principles of law which reported cases enunciated, his most singularly retentive memory, gave to

his professional career a distinction which was remarkable. His kindness to the young lawyers who asked his advice and legal aid was proverbial.

"Retiring from active practice his last years were devoted to public duties of a high order, and very much of his time was cheerfully given to advising and counseling in matters of individual interest and public importance. Such a character is worthy of memorial. Let it be inscribed on the scroll dedicated to our departed brethren of this Bar.

The last public occasion when Mr. Phillips took his recognized place as a member of the Bar was presiding at the Bar dinner given December 20, 1882, to the late Chief Justice of the Supreme Court of this State, Judge Sharswood, on his retiring from that exalted position. It was a memorable occasion. The Chief Justice was greeted by the profession he had honored, as a great jurist, whose professional, official, and private life ranked him among the ablest of the judiciary of our Commonwealth. Mr. Phillips thus with Judge Sharswood reached the end of their lives under the most appropriate surroundings. They both died in no long time thereafter.

Having acquired both reputation and an assured income, Mr. Phillips gave special attention to politics. Until both had been attained, he knew the unwisdom of intermitting attention to his vocation. Success at the Bar, success in any profession or business, is only secured by constant and unremitted application. A divided duty is half performed, or disregarded. This Mr. Phillips knew, and he patiently waited until he felt he could devote some time to other affairs. In 1856 he was elected from the 4th district of Pennsylvania to the Federal House of Representatives. He took his seat in the 35th Congress on December 7, 1857.

He was appointed on the Standing Committee on Elections, and had for colleagues the ablest lawyers in the House, John W. Stevenson, of Kentucky, L. Q. C. Lamar, of Mississippi, Israel Washburn, of Maine, James Wilson, of Indiana, and others.

Mr. Stevenson was afterwards elected Governor of Kentucky and United States Senator from that State, and Mr. Lamar is now in the Federal Senate from his State.

Mr. Phillips was also placed on the Special Committee on the Pacific Railroad, with John S. Phelps as chairman, and among his associates were Erastus Corning, W. S. Groesbeck, John A. Gilmer, O. R. Singleton, J. F. Farnsworth, &c.

It was thus that at the opening of his public life Mr. Phillips' reputation placed him among the foremost of our public men of that period.

His election to Congress was his first popular endorsement through the ballot box. His first step in the public arena was from the Bar to the Federal Legislature. Whatever of qualification he possessed for this trust was gained by that remarkable power of observation and absorption which emphasized his life. Instinctively he knew, or if he had to learn, he was preternaturally proficient. The method by which he acquired information and knowledge, attained what he sought, or what was required or necessary, is not easily explained. It was more an inherent faculty,

than a systematic process. It may be called a mental idiosyncrasy. However ill this may be as an explanation, yet it is the better description of Mr. Phillips peculiar mental temperament.

That Mr. Phillips devoted little, if any, time to general reading while actively engaged in his profession is known of all his friends. He wrote nothing on public questions, and indeed, made no contributions on current or special literary subjects. Yet his speeches in Congress were masterly and thorough on the questions he discussed.

On the 12th of June, 1858, he addressed the House of Representatives on *"The expenditures and revenues"* of the country, in which he discovered both knowledge and power, and made a mark as a debator. He met on this occasion in debate Mr. Sherman, of Ohio, then establishing his reputation. If he had not gained the ear of the House and impressed himself on the judgment of his colleagues as worthy of their consideration, a failure would not have been wondered at under the concomitant circumstances. That he did make a marked impression is known.

On the 9th of March, 1858, Mr. Phillips made a very able speech on "The admission of Kansas as a State under the Lecompton constitution." On this subject Mr. Phillips was in the line of his studies, and he manifested his familiarity with the questions involved in their discussion. That he made a deep impression on the House is shown by the record of the proceedings. He was very forcible, and ably presented his views, so much so, that Mr. Grow, Mr. Montgomery and Mr. Kunkel, of Pennsylvania, and Mr. Stanton, of Ohio, interrupted him to ask for information, and to support their understanding of facts, or to question the basis of his argument. Mr. Phillips was fortunate on all these occasions in strongly justifying his statements, or strengthening his positions. This speech, and the incidents attending its delivery, elevated its author to a position formidable in debate, and forcible in argument.

That Mr. Phillips had the faculty of acquiring knowledge by absorbing it as if without consciousness, can be affirmed from reading the two addresses to which reference is made. Entering Congress without any preparatory study of the business that was likely to engage the attention of the Federal Legislature; with no experience in public life; entrusted for the first time with the duties and responsibilities of a representative of the people; new in all its relations to his constituency and the country; surrounded by able and experienced statesmen; brought to the consideration of principles of the highest moment to the welfare of the United States, Mr. Phillips was able to discuss them with a self-reliance imperturbable, and a confidence in his own powers.

The two speeches to which notice has been called are selected out of his legislative record because the subjects are so wholly disconnected with each other, as more distinctly to demonstrate the view here taken of Mr. Phillips' character.

It was a remark often made by John W. Stevenson, his colleague in

Congress from Kentucky, afterwards governor of that State, and its representative in the Senate of the United States, one of the ablest and purest of the public men of this country, that Mr. Phillips was a very successful member of the House, and both in committee and on the floor was equal to any emergency. Governor Stevenson regarded Mr. Phillips' service on the Committee of Ways and Means in the 2d session of the 35th Congress, as proof of this estimate of his public character.

The proceedings of the House of Representatives for the sessions of the 35th Congress, as published in the *Congressional Globe*, prove the earnest, active part taken by Mr. Phillips on public questions, his aptitude in debate, his familiarity with and incisive mode of dealing with questions of parliamentary law. He was laborious in his attention to the business devolved on the Committee of Ways and Means, and faithfully served it by his watchfulness and promptitude, his comprehension of the questions under debate, and the facility with which he made his views understood by his colleagues in Congress.

The 35th Congress was remarkable not only for the character and attainments of so many of its members, but also from the questions with which it had to deal. That Mr. Phillips should have gained and maintained a prominent position during both its sessions is as likely as any other evidence to assure his deserved reputation.

On his retirement from Congress Mr. Phillips returned to his professional duties. For several years he was devoted to them, but from time to time he was induced to take an interest in matters of general public concern, and give his knowledge and experience for the benefit of his native city. He felt he ought to contribute his share to the welfare of Philadelphia, and from 1865 to 1875 he was engrossed in such service. Thus withdrawn from active practice, he became the counselor as he ceased to be the counsel. Though his advice and sound judgment were always sought, yet he confined himself to consulting and advising on subjects which were to be affected by the enactment of laws, as well as their determination and adjudication.

The city having been made the trustee under very many testamentary devises for objects of benevolence, and most especially by the will of Stephen Girard for purposes of the highest importance to the people of Philadelphia, especially, it was deemed advisable to unite the administration of these trusts in one body charged with this duty.

Mr. Phillips took great interest in this proposition. It was consummated, and on September 2d, 1869, he was appointed a member of this new organization, "The Board of City Trusts." Subsequently he was elected its vice-president, and then its president. His faithful and useful services in that board were fully recognized.

On the 16th of October, 1874, Mr. Phillips was selected as one of the directors of "The Pennsylvania Company for Insurance on Lives and Granting Annuities." His knowledge and experience qualified him for the discharge of the responsible duties of this position.

At the election of directors of the Pennsylvania Railroad Company, in March, 1874, Mr. Phillips was elected a director. He devoted very much of his time and attention to the responsibilities involved, with their ramified interests and urgent demands on his best judgment.

Desiring to aid in forming a correct taste, and encourage the love of music in Philadelphia, he was chosen as a director of the Philadelphia Academy of Music in 1870. His active exertions in the Board resulted in his election as its president in 1872. He resigned, however, from both in 1884.

The Court of Common Pleas on the 13th of May, 1867, appointed Mr. Phillips a member of the Board of Park Commissioners, and on March 12, 1881, he was elected president. He took a liberal view of the proper administration of this great public benefaction. His service on that board was earnest and important.

On the 4th day of December, 1862, Mr. Phillips was chosen a trustee of the Jefferson Medical College to fill the vacancy on the death of his brother, I. Altamont Phillips, likewise a member of the Philadelphia Bar. This medical school, with all its adjuncts for teaching and training in the curative art, with its world-wide reputation for the highest capacities in its faculty, and the substantial attainments of its graduates, called from Mr. Phillips anxious and continuous attention. Well did he devote it, not only with conspicuous assiduity, but with intelligent comprehension of its demands.

The Legislature of Pennsylvania passed, April, 1870, the law creating a commission entrusted with the erection of municipal buildings for Philadelphia. Mr. Phillips' advice was sought and his efforts enlisted to secure the legislation required. He was made a member of the commission by this act, approved by the Governor in August, 1870. On the 19th of October, 1871, he resigned.

At a meeting of our honored and venerable society held January 20, 1871, Mr. Phillips was elected a member.

In December, 1858, "The Grand Lodge of Free and Accepted Masons of Pennsylvania" elected Mr. Phillips Grand Master. In this distinguished station he made his administration creditable to himself and conservative of the interests of the craft. The duties devolved upon the Grand Master were in harmony with his character and acquirements, and the record of his term of service attests his fidelity to the trust, and sincere testimony of the appreciation of his brethren.

This is a brief narrative of Mr. Phillips' connection with some of the public institutions of Philadelphia, and it is obvious that such diversified duties as each placed on him, taxed his energies and absorbed his time.

So active a life was not likely to afford opportunities for the belles-lettres, cultivation of tastes, or the preparation of contributions to general literature. It is somewhat remarkable that no essay, treatise or paper on jurisprudence, literature, science or art, was ever prepared and published by Mr. Phillips. It is alike true that he never made a speech or public

address on subjects of public interest before a popular assemblage. This is so singular that to omit its mention would naturally invite criticism.

It was as remarkable that Mr. Phillips never visited any foreign country, or, indeed, any part of his own. He remained in Philadelphia, except short sojourns at Saratoga, or by the seaside during the summer months, yet he lived to the age of three-score years and twelve.

With traits of personal character that assured him devoted friends; kind, and more than considerate to the young lawyers who sought his advice in their first efforts; generous, when his left hand knew not the outgivings of the right; undemonstrative in his private relations; and retiring from a participation in social exactions; concerned for the happiness of those immediately connected with him by the nearest ties of kindred; living unmarried and without such domestic claims on his leisure hours; the public life of Henry M. Phillips is worthy of the respect which the American Philosophical Society desires by this notice to record and perpetuate.

Henry M. Phillips was a typical Philadelphian.

Those influences which surround the outgrowth of capacities in the men of high merit of our city, do not stimulate their appreciation by our own people. Our most distinguished citizens in literature, science, the arts and affairs, gain their fame by the recognition awarded by other communities. If perchance so fortunate, then Philadelphia, surprised at the discovery, permits its lethargic comprehension to utter tardy applause.

Biographical Sketch of Professor Samuel D. Gross, by J. M. Da Costa, M.D., LL.D.

(*Read before the American Philosophical Society, December 19, 1884.*)

Samuel Dent Gross was born in the neighborhood of Easton, Pennsylvania, on July the 8th, 1805. At school he was an industrious boy, and he received a good education at the Wilkesbarre Academy and the Lawrenceville High School He never went to college; but when at the age of nineteen he began to read medicine, it was evident that the young votary of science had been accustomed to intellectual labor, and was taking up his professional studies with no untrained mind.

On enrolling himself as a student at the Jefferson Medical College, of Philadelphia, he was at the same time an office pupil of Professor George McClellan, if one of the most eccentric, also one of the most original and successful surgeons of his day; and it is very likely that young Gross, who through life preserved a veneration for his brilliant preceptor, got his bias for surgery from this association. And how he worked as a student! Tales are still current at the College, transmitted through janitors and college servitors, and losing nothing in coloring by the diffusion through

the successive classes the eminent professor subsequently taught, of how immense had been his labors; how he rose with the early dawn; was never seen without a book under his arm; and had to be turned out from the anatomical rooms by the wearied attendants when the hour for closing them arrived. Certain it is he worked with his whole heart; and when he graduated in 1828 he was a noted man in his class.

He began the practice of his profession in a little office in Fourth street, in Philadelphia, and it is said that he had among the visitors who dropped in on him his future colleague, Joseph Pancoast. More friendly visitors than patients, it is to be feared, came to his rooms; for after about two years, his patrimony being nearly spent, he gave up the struggle in a great medical centre and returned to Easton. But he carried with him evidence of his love of learning and of his indomitable perseverance. He had in the short time translated from the French and the German works on General Anatomy, on Obstetrics, on Operative Surgery, and he had published his treatise on "The Anatomy, Physiology, and Diseases of the Bones and Joints." He also took away with him a wife, a lady of English descent of many accomplishments, who proved to him a true helpmate in his arduous career.

It was not long before Dr. Gross became a leading practitioner in the flourishing little town of Easton, and his scientific knowledge was so well appreciated that he was offered the Chair of Chemistry in the well-known College there seated, in Lafayette College. He declined it; but finding that within him which impelled him to become a teacher, he relinquished his growing practice to accept the demonstratorship of anatomy in the Medical College of Ohio, at Cincinnati. His stay at Easton had not been barren in additions to his scientific acquirements. He was constantly at work in a dissecting-room which he built at the foot of his garden. Here, too, he made a series of most careful observations on the rapidity with which articles taken into the stomach are excreted by the kidneys; and investigated the temperature of the venous blood, which he found as an average to be 96° Fahr. Further, he wrote a considerable part of a treatise on descriptive anatomy, in which an English in place of a Latin nomenclature was employed. This work was never finished; the experiments on the blood were published at Cincinnati in the second volume of the Western Medical Gazette.

As a demonstrator in the Medical College of Ohio, which he joined in the autumn of 1833, Dr. Gross was very successful. But he did not long remain in this position; for after the work of two sessions he accepted the Chair of Pathological Anatomy in the Medical Department of the Cincinnati College. He threw himself with even more than his usual ardor into the subject, and the number of specimens he studied and collected was great, and the extent of his reading enormous. It was the pursuit of Pathological Anatomy, on which he gave the first systematic course delivered in this country, which made him so learned and skilled a surgical diagnostician, and he cherished through life a great devotion to the

branch. Nor was his association with it limited to the four years he taught it from the professor's chair. His "Elements of Pathological Anatomy," issued in 1839 in two octavo volumes of more than five hundred pages each, did more to attract attention to the subject than anything that had ever been done in this country. The book, illustrated profusely with woodcuts and with several colored engravings, reached three editions. It is a mine of learning, and its extended references make it valuable to this day. Its merits have been fully recognized abroad; and on no occasion more flatteringly than when the great pathologist, Virchow, at a dinner given to Dr. Gross at Berlin in 1863, complimented him publicly on being the author, and, pointing to the volume which he laid upon the table, gracefully acknowledged the pleasure and instruction with which he had often consulted it. As another acknowledgment of its merits, we find that soon after the publication of the second edition the Imperial Royal Society of Vienna made Dr. Gross an honorary member.

Dr. Gross remained six years in Cincinnati, popular as a teacher, and gradually acquiring a large general practice; but with a stronger and stronger predilection for surgery. It was this chiefly which led him to accept the Professorship of Surgery in the University of Louisville; and with the removal to Louisville in 1840 Dr. Gross' national reputation may be said to begin. Patients flocked in on him from all sides. He soon became the leading surgeon of the Southwest, being often called away long distances into the interior of Kentucky and adjacent States. He lived in a large house in a very hospitable manner, and with a young family around him the house was gay and pleasant, and a centre for men and women of mark.

But neither the claims of practice, nor the demands of social life, quenched his thirst for work. He published, besides many papers in the Western Journal of Medicine and Surgery, a most valuable monograph on the "Nature and Treatment of Wounds of the Intestines," which contained many original experiments and observations. He printed full biographies of Daniel Drake and of Ephraim McDowell,—the surgeon who had the boldness to be the first to perform ovariotomy, and through whose boldness, it has been computed, thousands of years have been added to human life. He wrote a lengthy report on the "Results of Surgical Operations in Malignant Disease;" published a treatise on "Diseases of the Urinary Organs," which soon became an acknowledged authority, and has passed through several editions; wrote a work on "Foreign Bodies in the Air Passages," from which all subsequent authors have largely copied their facts, and of which the distinguished laryngologist, Morrell Mackenzie, has declared that it is doubtful whether it ever will be improved upon. Part of all the enormous labors necessary to complete these and other literary undertakings was performed in New York, where Dr. Gross passed the winter of 1850–51, occupying the Chair of Surgery in the University of New York, which had been rendered vacant by the retirement of the then most famous operative surgeon of this country, Valentine Mott.

But, however pleasant he found the social life of the great city, he deemed it best for his own interests not to tarry there, and he returned to Louisville; his late colleagues received him with open arms, and his successor, Dr. Eve, with generous abnegation, retired to let him renew his teachings from his old chair. It seemed that nothing would again take Dr. Gross away from Louisville, where he became a very prominent citizen, in whose reputation all took pride. But in the spring of 1856 came the offer which he had not the heart to resist; the call from his Alma Mater to fill the Chair of Surgery, vacated by the most popular professor of the branch in this country; the idol of the largest classes then assembling in any medical school in America. To succeed Thomas D. Mutter was a trial to any one. But Dr. Gross, conscious of his powers as a teacher, in the prime of life and of vigor, ambitious to connect his name forever with that of the College where he had been educated and which a band of eminent men had made so flourishing, accepted the task without misgivings, and the result was unmixed success for himself and great benefit to the Institution. Many were the remonstrances against his leaving the home of his adoption, and he did so, he tells us himself in his inaugural address, against the inclinations and wishes of his family. Moreover, he was very loth to sever his connection with the University of Louisville "for sixteen years the pride and solace of my professional life." And it was the simple truth when he stated that in making the change and coming to Philadelphia, he, the most noted surgeon of the Southwest, had left behind him an empire of Surgery.

His inaugural address was very favorably received. His impressive voice, his splendid intellectual appearance, the earnestness and force of his words, the latent power which all his utterances and actions showed, carried away his audience; and when in solemn tones he spake these words of his peroration "Whatever of life, and of health, and of strength, remains to me, I hereby, in the presence of Almighty God and of this large assemblage, dedicate to the cause of my Alma Mater, to the interests of Medical Science, and to the good of my fellow-creatures," it was felt that a man of great strength and earnest endeavor had come among us.

Never were thoughts more faithfully put into action. Dr. Gross was indefatigable, and became a celebrated teacher, deeply devoted to the school, the reputation of which he enhanced greatly. Indeed, it may be said, without injustice to any one, that for years he was the most commanding figure and the most popular teacher in it. Nor is it enough to judge him only by those around him or who held similar chairs in other institutions. It is not the recollection of many acts of encouraging kindness from an older to a younger man; it is not the pride of a colleague in the great reputation of one to whom all looked up,—which makes the writer of these lines say that in his profession Samuel D. Gross takes rank with the very few of the most renowned teachers of his day. To assign him his proper position he must be named with the Hyrtls, the Trousseaus, the Pagets. Less finished in eloquence he may have been, but in

perspicuity and impressiveness and in influence on his hearers he was not one whit behind. Seeing him standing in his lecture room, you saw the man at his best. The learning, the method of his discourse, its clearness and fullness were not more admirable than the force and directness of the words which, uttered in his deep and agreeable voice, sank into the minds of his youthful audience. Years afterwards men whose hair was turning gray would cite the strong words of the lesson the great teacher had made part of the guiding thought of their daily lives.

His didactic lectures were probably his best, though his clinical discourses were also models of perspicuity. He was least happy in his addresses, delivered as introductories or valedictories, or on special occasions. During his long and busy life he wrote many of them, some of considerable historical value, such as the Life of Mott, of John Hunter, a discourse on Ambrose Paré, an oration in honor of Ephraim McDowell. As these discourses were always written out, he read them from manuscript. But he was not a good reader, and no one to hear him would suppose that it was the same man who, great professor that he certainly was, had, when speaking without notes to his class, their unflagging, devoted attention. Strange to say, too, for one who wrote so well, the addresses show faults which appear nowhere else. They do not possess the art of leaving things unsaid, hence there are at times repetitions in them, marring their general efficiency. They have force—for it was impossible for this strong man to do anything that has not force—but they lack literary perspective.

Nothing of the kind, however, appears in his scientific writings. On the contrary, they are as concise, as vivid as it is possible to be. Nothing but strong thoughts, nothing but clear words. And Dr. Gross acquired this excellent style to such perfection that he wrote pages without a single correction. A most critical proof-reader once informed the writer, that of all the authors he had ever known, Dr. Gross altered least, his proof was the cleanest, there was scarcely a correction to be made or suggested.

His literary pursuits were unremitting during his residence in Philadelphia. Memoirs, reviews, essays on surgical subjects appeared in rapid succession; no sooner was one done than another was under way. In conjunction with Dr. T. G. Richardson, he was for a time editor of a flourishing journal, the North American Medical Chirurgical Review. He was also editor of, as well as chief contributor to a volume bearing the title of "Lives of Eminent American Physicians and Surgeons of the Nineteenth Century." And in 1876, as a contribution to the literature of the Centennial year, appeared a lengthy and extraordinary learned history of American Surgery from 1776 to 1876. As an instance of the rapid manner in which, if necessary, he could work, may be mentioned, that at the outbreak of the Civil War, he composed a pocket manual of Military Surgery in nine days, which was largely used by the young surgeons in the service of the United States, was soon republished in Richmond and equally employed by the surgeons of the Southern armies. A Japanese

translation of this little work appeared in 1874, and is still in use among the military surgeons of this enterprising nation.

But the great work he completed in Philadelphia, one by which his name will be long remembered, is his "System of Surgery," a work of which the first edition was published in two very large, profusely illustrated octavo volumes in 1859, and which in 1882 reached its sixth edition. The labor on it, and on the successive editions which brought it up to its present perfection, was enormous. Rising early, working late, writing with an assiduity that only a man of his wonderful physique could have kept up, he generally gave from five to eight hours a day to the cherished project, no matter what the interruptions or whatever else he had to do. Often, too, he would think out, while driving about town on his professional visits, the subject he was engaged on, and commit these thoughts to paper, on his return home, before he took rest or food.

The treatise on Surgery has become everywhere a standard authority. "His work is cosmopolitan, the surgery of the world being fully represented in it," says the Dublin Journal of Medical Science. "Long the standard work on the subject for students and practitioners," is the verdict of the London Lancet of May of this year, on the twenty-three hundred and eighty-two pages of the last edition. A Dutch translation was issued in 1863.

Dr. Gross always took the keenest interest in every question relating to his own profession and in its honor and advancement. He was a very constant visitor at Medical Societies in various parts of the United States and in Great Britain. He was probably known personally to more physicians and men of science than any other man in the United States, and wherever he went he had many followers and admirers. Most of the prominent surgeons of England were his personal friends. His interest in Medical Societies never flagged, and late in life he became the founder of two very flourishing ones, of the Academy of Surgery of Philadelphia and of the American Surgical Association. He served as president of both. In 1868 we find him as President of the American Medical Association at its meeting in Washington; and in 1876 as the President of an International Medical Congress in session at Philadelphia. He was a member of most of the noted medical societies of this country, of the Academy of Natural Sciences, and of this Society. He was also a member of many learned societies abroad; among them, of the Royal Medical Chirurgical Society of London, the Clinical Society of London, the Imperial Medical Society of Vienna, the Medical Society of Christiana, the Royal Society of Public Medicine of Belgium.

But his highest foreign honors were conferred upon him by the three great English Universities. D.C.L. of Oxford, in 1872, at the one thousandth commemoration of the University; LL.D. of Cambridge in 1880, in the same list with Brown-Sequard, with Donders, with Joseph Lister; LL.D. of Edinburgh *in absentia*, a compliment the more marked since it was only shared with Tennyson and a few others of great distinction,—the renowned American Surgeon carried honors which

few of his countrymen have ever borne together. His welcome at Oxford on Commemoration Day was very enthusiastic. His commanding appearance made him conspicuous even among the distinguished men who surrounded him, and a lady who was present told the writer that she felt a glow of patriotic pride in witnessing his warm reception and hearing the flattering remarks his splendid bearing elicited. At Cambridge the Public Orator addressed him as "Patriæ nostræ ad portus nuper advectus est vir venerabilis quem inter fratres nostros Transatlanticos scientiæ Chirurgicæ quasi alterum Nestorem nominare ausim." Of American colleges, to their shame be it spoken, only two, Jefferson College in 1861, and the University of Pennsylvania in 1884, bestowed on him any honorary degree in recognition of his great literary and scientific merit.

In March, 1882, Dr. Gross found that his physical strength was scarcely adequate to the arduous labors of his chair, and, while mentally as fit as ever, he resigned his cherished Professorship of Surgery. The Trustees at once elected him Emeritus Professor, and it was a great gratification to him to find that, in dividing the chair into two, they selected his son, Dr. Samuel W. Gross, to fill one part of it.

The remaining years of Dr. Gross's life were passed in pleasant retirement, but not idly. He had for years in Philadelphia been busy as a consulting Surgeon, and in a large office practice, and to a certain amount of this he attended to the last, his great reputation bringing him still many a patient from a distance. He also wrote diligently on an autobiography, published a paper "On the value of early operations in Morbid Growths;" another "On the best means of Training Nurses for the Rural Districts," a subject in which he was much interested; and composed two essays, one of them, on "Wounds of the Intestines," but a few weeks before his death. His hospitality, his genial manners were the same as ever; nay, advancing years softened the whole man, and made him more benign and more and more beloved. He was delightful in his own home, always surrounded by friends, adored by his family. The best of fathers, he had the constant companionship and care of the most devoted of children.

In the autumn of 1883 he showed symptoms of a weak heart; his feet were swollen, partly from dropsy, partly from rheumatic gout, and he had a long attack of bronchial catarrh. But he improved and held his own fairly well, notwithstanding signs that his digestive functions were failing, until after a severe cold in March, these began to give way entirely, and he died of exhaustion, May the 6th, after a long and most trying illness, which he all along regarded as his last. The deepest sympathy and affection were everywhere expressed for him. Telegrams and letters came daily, inquiring after him; old pupils, busy men, traveled hundreds of miles to grasp him once more by the hand. To very many his death was a deep personal sorrow.

An autopsy, made at his own request, showed that the stomach and heart were degenerating. He had lived out the life of possible strength; to have lived longer would have been to enter upon a life of suffering. His death

saved him from protracted inaction and pain, from what Heine, in his own case, has pathetically bewailed as the "mattress grave." By special directions in Dr. Gross's will the body was cremated, and the ashes have been placed beside the coffin of his wife in Woodlands Cemetery.

Such is a sketch of the life of this prodigious worker. An original contributor to the science for which he had a fondness; a widely known practical surgeon; an admirable, most learned writer; a great teacher exerting an influence which will long survive him,—Dr. Gross occupied the foremost rank in the medical profession. It was evident from his student days that he was to be a man of rare distinction:

> "Mens ardua semper
> A puero, tenerisque etiam fulgebat in annis
> Fortunæ majoris honos."

He, certainly, was of the men whose high fortune throws its shadows before from the earliest years. The youth showed what the mature man was; the old man was but the youth with the promise fulfilled, and with honors gracefully worn that no one ever doubted would be attained. A part of his extraordinary fame is due to the circumstances under which he worked. He was the first writer on this continent who, with anything like gift of expression, brought together and elaborated the truths of surgical science, and partly this, but chiefly the excellence of his labors, extended his reputation in all directions beyond his own country. In acquiring fame for himself, he added to her fame. Conspicuous in many ways, Samuel Dent Gross stands forth a marked personality among the eminent men of our or of any generation.

Stated Meeting, Dec. 19, 1884.

Present, 15 members.

President, Mr. FRALEY, in the Chair.

Letters of acknowledgment were received from the University of California and the Royal Society of Victoria, Melbourne (112, 113).

Letters of envoy were received from the Argentine Observatory, the Department of Internal Affairs at Harrisburg, and Mrs. John Biddle of Philadelphia.

Donations to the Library were received from Mr. H. J. Browne of Victoria; the Bureau of Statistics at Stockholm;

the Royal Academy and Royal Observatory of Belgium; the Geographical Society at Paris; the Annales des Mines; the Lords Commissioners of the Admiralty, the Meteorological Council of the Royal Society, and London Nature; Mr. J. Lowthian Bell; Dr. Benjamin Ward Richardson; Mr. E. W. Maunder; the Natural History Society of Northumberland, Durham and New Castle-upon-Tyne; the Boston Society of Natural History; the Museum of Comparative Zoölogy; the American Society of Civil Engineers; Yale College; the Meteorological Observatory of New York; the College of Physicians; the Second Geological Survey of Pennsylvania; the Johns Hopkins University; the U. S. Bureau of Ethnology, and Coast and Geodetic Survey; Rev. Stephen D. Peet, of Chicago; the National Academy of Sciences, and the National Observatory of Cordoba. Also, a valuable set of books on India, bequeathed to the Society by the late John Biddle, Esq., of Philadelphia.

Mr. Vaux read by appointment an obituary notice of the late Mr. Henry M. Phillips.

Dr. DaCosta read by appointment an obituary notice of the late Samuel D. Gross, M. D.

Prof. Cope communicated a paper entitled "Twelfth Contribution to the Herpetology of Tropical America."

Mr. Ashburner described the recent publications of the Second Geological Survey of the State.

The Committee on two applications for the Magellanic premium reported adversely to the applications.

The report of the Finance Committee was read and approved, and the appropriations for 1885 recommended therein were adopted, and the meeting was adjourned.

The remarks of Mr. Ashburner were as follows:—

In 1874 the Second Geological Survey of Pennsylvania was organized. Up to the present time there have been issued sixty reports (edition of 5000 copies) of progress and eleven atlases of maps and sections, in octavo volumes, to accompany these reports. In addition to these, within the last month, there has been published a large atlas of unfolded sheets of the Anthracite Survey, constituting the first part of a series of similar atlases which will ultimately form the grand atlas of the survey. A copy of

this Anthracite atlas has been transmitted to the Society during the past week, and it may be of interest to the members to know something of the plan which has been adopted for the publication of these grand atlas sheets. The direction of the publication of these atlases has been placed under my charge.

Since the commencement of the Survey, there have been numerous sheets of geological maps and sections published to accompany the reports of progress. These sheets have been printed on light paper and folded in octavo atlases, or in a pocket of the reports. Anticipating a demand which might arise for copies, upon heavier unfolded sheets from which measurements could be made, of those maps and sections which were of a more permanent character, an edition (1000 copies) of such maps and sections has been printed on heavy atlas paper, the size of the sheets being 26 x 32 inches, except in one or two special cases. This size of sheet was adopted on account of its being that upon which the maps and sections could be most economically adjusted, and not as being a convenient one for handling.

The Grand Atlas has been divided into five divisions. Although all of the sheets to be contained in any one of these five divisions are not as yet printed, or even all constructed, it is proposed at the present time to issue, in individual parts, the sheets of each division which have been printed; as other sheets shall be printed under the five divisions respectively, they will constitute a second part of the same division. It is designed, however, not to issue a separate part of a division until the sheets shall aggregate twenty to twenty-five in number.

Division I will contain the geological maps of the counties constructed on a scale of two miles to one inch, 1-126,720th of nature. In the notes of explanation accompanying Part 1 of the county geological maps, containing forty-nine sheets, covering fifty-six counties, which is now in press, and which will shortly be issued, Prof. Lesley says: "None of these county maps are correct, and it is a rare occurrence that any two or three maps can be joined together to form one connected whole. The geology of the counties has been outlined on the maps from outcrops, located with reference to some topographical or geographical feature determined on the ground, the position of which appears on the map. As a result of this method, the geological outlines, at a line common to adjoining maps, do not always meet, the geology on each being referred independently to the topographical and geographical features of the two maps, which do not themselves agree along the common line. In some cases adjustments have been made, especially where the geology of several adjoining counties was mapped by one assistant geologist. In cases where topographical maps have been made by the Survey, the geology has been outlined on them, and that portion of the county map containing such surveys has been made to agree with them. Although it would be practically impossible to construct an accurate geological map of the entire State from a compilation of the county geological maps, yet it is apparent that when an accurate topo-

graphical map of the State from original surveys shall have been made, the geology can then be outlined upon it, by using the information contained on these maps, with very little additional work in the field."

Division II, will contain the sheets of the Anthracite Survey. These sheets will be grouped under the following heads:

Mine sheets, scale 800 feet to one inch, 1-9600th of nature. The area covered by each sheet, inside of the border lines, is 15.67 square miles. On these sheets will be represented the plan of all the mines and the shape of the floor of the most extensively developed coal bed (Mammoth bed principally), where mined, and its most probable structure in undeveloped areas, by contour curve lines fifty feet vertically apart; also the surface geological features.

Topographical sheets, scale 1600 feet to one inch, 1-19,200th of nature. The area embraced within the border line of each sheet is 62.68 square miles. On these sheets will be represented the topography of the surface by contour curve lines ten feet vertically apart.

Cross section sheets, containing vertical cross sections, scale 400 feet to one inch, 1-4800th of nature, showing the shape of the coal beds, where mined, and their most probable structure in undeveloped areas, accompanied by special maps and sections of the areas referred to, on various scales.

Columnar section sheets, containing perpendicular columnar sections, showing the thickness and character of the coal measures, scale forty feet to one inch, 1-480th of nature; and of the coal beds, scale ten feet to one inch, 1-120th of nature; accompanied by special sections and diagrams on various scales.

Miscellaneous sheets, containing special illustrations directly connected with the history, mining and geology of the region.

Division III, will contain the maps and sections relating to the petroleum and bituminous coal fields, published on various scales.

Division IV will contain the topographical maps, from the surveys of A. E. Lehman, of the South Mountain in Adams, Franklin and Cumberland counties, and the topographical maps of the Great Valley between Easton and Reading, constructed from the surveys of Messrs. d'Invilliers, Berlin and Clarke. These maps are published on a scale of 1600 feet to one inch, 1-19,200th of nature, and the topographical features are delineated by contour curve lines, either ten or twenty feet vertically apart.

Division V will contain the geological maps and sections relating principally to the Silurian and Devonian formations in Central Pennsylvania, and geological cross sections of the Philadelphia rocks in the south-eastern portion of the State.

him the communication, description, or model, except the officer to whom it shall be entrusted; nor shall such officer part with the same out of his custody, without a special order of the Society for that purpose.

6. The Society, having previously referred the several communications from candidates for the premium, then depending, to the consideration of the twelve counsellors and other officers of the Society, and having received their report thereon, shall, at one of their stated meetings in the month of December, annually, after the expiration of this current year (of the time and place, together with the particular occasion of which meeting due notice shall be previously given, by public advertisement) proceed to final adjudication of the said premium; and, after due consideration had, a vote shall first be taken on this question, viz.: Whether any of the communications then under inspection be worthy of the proposed premium? If this question be determined in the negative, the whole business shall be deferred till another year; but if in the affirmative, the Society shall proceed to determine by ballot, given by the members at large, the discovery, invention or improvement most useful and worthy; and that discovery, invention, or improvement which shall be found to have a majority of concurring votes in its favor shall be successful; and then, and not till then, the sealed letter accompanying the crowned performance shall be opened, and the name of the author announced as the person entitled to the said premium.

7. No member of the Society who is a candidate for the premium then depending, or who hath not previously declared to the Society, that he has considered and weighed, according to the best of his judgment, the comparative merits of the several claims then under consideration, shall sit in judgment, or give his vote in awarding the said premium.

8. A full account of the crowned subject shall be published by the Society, as soon as may be after the adjudication, either in a separate publication, or in the next succeeding volume of their Transactions, or in both.

9. The unsuccessful performances shall remain under consideration, and their authors be considered as candidates for the premium for five years next succeeding the time of their presentment; except such performances as their authors may, in the meantime, think fit to withdraw. And the Society shall annually publish an abstract of the titles, object, or subject matter of the communications, so under consideration; such only excepted as the Society shall think not worthy of public notice.

10. The letters containing the names of authors whose performances shall be rejected, or which shall be found unsuccessful after a trial of five years, shall be burnt before the Society, without breaking the seals.

11. In case there should be a failure, in any year, of any communication worthy of the proposed premium, there will then be two premiums to be awarded the next year. But no accumulation of premiums

shall entitle the author to more than one premium for any one discovery, invention or improvement.

12. The premium shall consist of an oval plate of solid standard gold of the value of ten guineas. On one side thereof shall be neatly engraved a short Latin motto suited to the occasion, together with the words: "The Premium of John Hyacinth de Magellan, of London, established in the year 1786;" and on the other side of the plate shall be engraved these words: "Awarded by the A. P. S. for the discovery of——A.D.——." And the seal of the Society shall be annexed to the medal by a ribbon passing through a small hole at the lower edge thereof.

SECTION 2. The Magellanic fund of two hundred guineas shall be considered as ten hundred and fifty dollars, and shall be invested separately from the other funds belonging to or under the care of the Society, and a separate and distinct account of it shall be kept by the treasurer.

The said fund shall be credited with the sum of one hundred dollars, to represent the two premiums for which the Society is now liable.

The treasurer shall credit the said fund with the interest received on the investment thereof, and, if any surplus of said interest shall remain after providing for the premiums which may then be demandable, said surplus shall be used by the Society for making publication of the terms of the said premium, and for the addition, to the said premium, of such amount as the Society may from time to time think suitable, or for the institution of other premiums.

The treasurer shall, at the first stated meeting of the Society in the month of December annually, make a report of the state of said fund and of the investment thereof.